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Japan Report

(FOUO 16/81)

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CONTENTS

SCIENCE AND TECHNOLOGY

CHANGES IN JAPAN'S INDUSTRIAL STRUCTURE IN 1980'S PROJECTED

New Frontier Technology

Tokyo NIHON KEIZAI SHIMBUN in Japanese 1 Jan 81 p 7

[Text] Even though the entrepreneurial environment is uncertain, the industrial world is constantly seeking an opportunity for growth and possible development. There are ceaseless challenges there. Propelled by the variety of spearheading technologies--new materials of every kind, circuit elements, electronics, mechatronics (electronics applied to machines), biotechnology, soft energy paths (new, non-petroleum based energy sources), high density engineering and so on--the new frontier is opening up in every field--market, organization, operational know-how. Against the background of the rapid progress of technological revolution and diversification of social needs, the outskirts of the new frontier for the businesses to conquer are expanding ceaselessly in the closing decades of the 20th century and will continue to do so into the 21st century.

"How to Select the Winners"

The cabinet negotiations toward the close of last year finally brought about the revival of a budget for development of basic, advanced technology in the 1990's and the 21st century. This is the MITI (Ministry of International Trade and Industry) Industrial Technology Agency's "Basic Technological Research Development System for Industries of the Next Period." The intent of the new enactment is to focus on three leading basic technology topics--new materials, biotechnology and computer element with new function--and to seek cooperation of both government and civilian sector (capitalize on government funding and civilian activity) in establishing an efficient development format.

Heralding this announcement, the industrial world has been active since early fall of last year. Five chemical firms--Mitsubishi Chemical Industries, Ltd., Sumitomo Chemical Co., Ltd., Asahi Chemical Industry Co., Ltd., Kyowa Hakko Kogyo Co., Ltd., Mitsui Toatsu Chemicals, Inc.--initiated the Biotechnology Conversazione (Chairman: Eizo Suzuki, President, Mitsubishi Chemical Industries). On the other hand, Tokyo Shibaura Electric Co., Ltd., Asahi Glass Company, Limited, Ishikawajima Harima Heavy Industries Co., Ltd., Kyoto Ceramics, Kobe Steel, Ltd., Sumitomo Electric Industries, Ltd., NGK Insulators Ltd., NGK Spark Plug Co., Ltd. and the Advanced Processing Equipment Technology Promotion Association organized a Fine Ceramics Conversazione (Chairman: Fujio Tanatsugi, Toshiba Vice President).

With regard to the new materials, a portion of early technologies in such fields as fine ceramics (a highly sophisticated technology involving solid inorganic matter) and biotechnology have already been put to practical use by the manufacturers. Nevertheless, the real research/development in these fields is yet to come; and the real flowering of new industries is expected during the 1990's and the beginning of the 21st century.

The new system is an attempt to choose the winners. In the same manner that the Japan Joint Stock Corporation nurtured and strengthened computers and LSI (large scale integrated circuits) and thereby pushed Japan's electronics industry into a crowning position in the world, the aim now is to focus on new materials, biotechnology and new engineering elements. Predicating that these are the large-scale technologies which will support the industrial foundations of the future, the new system will nurture and strengthen them.

Fusion of [Technological] Seeds (Impetus) and Needs

The industrial world's frontier region lies where the technological "seeds"--ultimate in technological possibilities--and people's social needs cross over. In some instances the technological seeds (impetus) precedes social needs and opens up the horizon for the latter; that is, sometimes the pattern is seed induced; and at other times, social needs precede the technology. In order to fill the social needs, necessary technologies are gathered and/or combined--in other words, the pattern is needs induced. In the seeds induced proper, technological seeds itself formulates new markets. At the same time, the scope of application is enlarged in response to diversification of social needs. The technological ripple effect is not only large, but impact onto other industrial sectors is significant as well. We are dealing with a large-scale technology. The semiconductor revolution led by super LSI, C_1 chemistry--a new organic chemistry technique that will replace the petro-chemistry, fine ceramics--said to be the third raw material following in the footsteps of metal and plastic, biotechnology--considered to be a major future technology employing biochemical reaction, nuclear fusion--a dream energy source--are the representative samples.

In the needs induced proper, technological seeds that germinate, grow and become established in one sector are transplanted (technology transfer) into another field or else, several technological seeds are combined in a so-called system technology to solve a social need and a new market is thereby created. The representative samples of this pattern are: mechatronics--transfer of electronics technology into the machinery industry sector, engineering plastic which added conductability and hear resistance to plastics, space and oceanic exploration which marshalled every possible advanced technology in attempting to conquer the two new frontiers.

According to the long-term surge pattern of technological revolution, 1980 and the 1990's are said to be still a period of accumulation, not blessed with a major break-through technology (new discoveries and inventions). However, 1975 is regarded as the change-over date from a downward trend to a period of upswing. Super-LSI, fine ceramics, biotechnology are believed to be the guiding lights in breaking through the period of stagnation and launching into an upswing orbit. It is no doubt true that the pace of technology transfer and system technology and their flowering are significant contributing factors.

Technology transfer and system technology, in particular, compensates for stagnation attendant upon a technological revolution. At the same time, the needs of the times--rationalization, energy and resource conservation, development of new products and so on--have expanded greatly. It is anticipated that in the 80's and 90's, along with research development in advanced basic technology fields and the resulting new markets, market formation via technology transfer and/or system technology will also make significant progress.

Competition Among "Unrelated Businesses"

According to a survey conducted by the Mitsui Bank, fine ceramics already has a market configuration of 100 billion yen. Laser whose application is very diverse--in communication, high precision processing, uranium concentration--is expected to have a 550-750 billion yen market by 1985. Super-LSI is expected to grow to a 1 trillion yen business by 1990. Nippon Electronic Machinery Industry Association (Chairman: Sadakazu Shindo, Chairman, Mitsubishi Electric Corporation) predicts electronics industry's production volume for 1981 to be 9,770 billion yen--an increase of 12.9 percent over the previous year. The birth of another 10 trillion yen market--succeeding the automobile industry (including parts)--is quite near.

Traditionally the new territory that technological seeds cultivates has been subject to fierce competition among the existing businesses, but in new domains opened up by technology transfer or system technology, neither the new nor the established businesses have the advantage. Previously completely unrelated businesses, new and old, are in competition for technological development and the market place.

Although Japanese businesses already have the world's foremost ability in creating markets by taking advantage of the technological revolution--say, by technology transfer--we are still quite a bit inferior to the Western states--Europe and the United States and especially to the latter--in advanced basic technology research/development. For the industries of Japan, the urgent issue is: "How are we to strengthen the research/development capability in these fields?"

Transformation in Technological Content Near

(Comment by Noboru Makino: Vice President, Mitsubishi Comprehensive Research Laboratory)

The mainstream of technology up to the 70's--represented by Shinkansen--was "system" oriented. In the 80's they are "single shots"--biotechnology, laser, amorphous material. However, they will not dominate a gigantic market singly. Electron's properties may be converted to light or a material will be given a desired functional character. In effect, they will alter traditional technology's inner core. It is necessary for businesses to seize upon major progress in basic technologies but it is expected that application will become several fold more complex than the current "micro-computer revolution" and the burning question will become: How to apply the new technology.

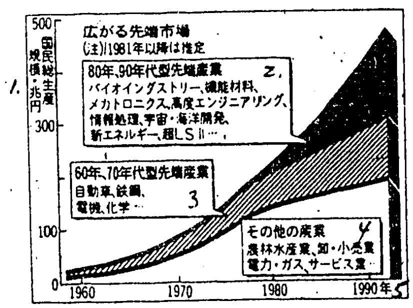

Figure: Expanding Advanced Technology Market
(Note) Post 1981 figures are estimates

Key:

1. Total production (State and Civilian)
   Scale: 1 trillion yen
2. Advance technology industries in 1980's and 1990's
   bio-industry, engineering materials, mechatronics, advanced engineering, data processing, space/oceanic development, new energy, super-LSI....
3. Advanced technology industries in 1960's and 1970's
   automobile, steel, electric equipment, chemical....
4. Other industries
   agriculture, forestry and marine products; wholesale and retail businesses, electric power/gas, service industry
5. Year

New Materials Are Key

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 20 Dec 80 p 1

[Excerpt] Up until now Japan has been able to effect a high degree of growth by introducing advanced technology from the West and subsequent follow-up developments efficiently executed. It is of course necessary to capitalize on the Japanese specialty of improving, enhancing and systemizing the existing technology, but at present, introducing advanced technology is becoming more and more difficult, and we need development of creative and independent technology. If we have superior and independent technology, through a give and take exchange, induction of other desirable technologies will be possible. Japanese participation in international cooperative development is not feasible unless Japan becomes an attractive and capable partner. Successful cooperative development would eliminate economic friction and it would also mean that we have contributed to the world's well-being as an economic power. At the very least, it would help erace Japan's image as "seller of goods for monetary profit."

It is said that there are five levels to technology. At the top are the Nobel Prize class innovations--such as the transister effect. Second level is the future technology such as Josephson element. Third is advanced technology such as super-LSI or photo-optic communication. Fourth is applied new products technology such as pocket calculators and automatic cameras. Fifth is reform technology such as miniaturization of television, economy sized tanker and so on. Reona Ezaki calls technology which contributes to the world's well-being as primary innovation; one which raises Japanese technological level above and beyond business gain as secondary innovation, and an invention or discovery which contributes to business profit is called tertiary innovation. What Japan needs in the future are the first two categories. Ultimate technology such as utilization of super-high pressure or extreme low temperature, food production by genetic regrouping, life sciences technology such as artificial organs which function in place of natural ones in a human body system, energy technology such as nuclear fusion are cited as the technologies of the next generation. These advanced technologies are synonymous with development of new materials. Materials are a very important aspect of technological development. As shown in the case of transister and nylon, if we trace the origin of the technological revolution, we inevitably come to a technological breakthrough in the form of a "revolutionary material." The fact that the materials revolution will continue to be the foundation of innovation will not change in the future. This is well illustrated by the fact that the MITI in its "Basic Technological Research/Development System for the Industries of the Next Period" and the Science and Technology Agency in its "Promotion System for Creative Scientific Technology" will deal seriously with materials research from next year. We should listen to Makoto Ishigaki's (Industrial Technology Agency Chief) cry that "the materials which we are about to focus on have been under research/development in the United States for quite some time and we have no time to lose."

The question then is the research/development cost. Civilian businesses are hampered by entrepreneurial limitations. Although materials may be "key technology," the businesses cannot afford to take the risk. The outcome of materials development is uncertain--that is, no one knows whether the result will be usable or not. Thus, the state must assume leadership in this field. A nation bearing the heavy cross of reconstructing public finance cannot selectively favor technology. But in as much as Japan seeks to become a technologically independent state with creative, autonomous technologies and to use them as bargaining power to secure economic stability, funds ought to be appropriated somehow. For this reason, we should reconsider Toshio Tsuchimitsu's (Japan Federation of Economic Organizations Honorary Chairman) suggestion of issuing science/technology government bonds. These will be paid by those who will benefit from the innovations in the future and are different in nature from the inflationary government securities which benefit the people now at the expense of the future generation.

The Finance Ministry is accused of being even more timid toward assuming research/development risks than civilian businesses. That is to say, failures are not tolerated. Thus the prospect of success must be nearly 100 percent before the support machinery is set in motion. Technological breakthroughs cannot originate in such an environment. If one were to say that civilian activity should be the foremost force, then perhaps Kyoto Ceramics President Kazuo Inamori's research contract system concept ought to be examined seriously.

A survey of research/development investment figures for various industries demonstrate that the highest spending figures are held by the steel, automobile and telecommunication fields. All are Japan's strategic industries. This proves the need for research/development investment. In order for Japan to create a uniquely creative, autonomous technology that would win the respect of the world, we must cultivate talents. The current Japanese educational system tends to stifle individuality and speciality. For example, a child is told, "Since you are good in mathematics, put your effort into your weak subjects--language and English." This is an educational approach that kills creativity. Each person has creativity within him and it cannot be measured on a point system. Memory can be numerically assessed but we have not heard that a person with good memory is also inventive.

The fact that the number of applicants to the Invention League sponsored the "All Japan School-Age Children's Invention and Design Fair" drops off drastically in junior and senior high school age categories--that is, as they grow older--and that content-wise, grade school children and in particular the lower ages demonstrate superior ideas must point an accusing finger at the current educational philosophy (including the entrance examination problem). Why are we departing from the sound advice voiced by Sopy's Honorary Chairman Kashira Ibuka and the Tokyo Institute of Technology President Shinroku Saito: "World class science/technology needs the same approach we take for music and sports. One must start young."

It is further said that compared to the United States and Europe, Japan is inferior in training the post-school age personnel. In the civilian sector the consideration of profit comes foremost and there is a tendency to use researchers only as they serve the business ends. During the 35 years after the war, formerly lustrous industries passed on from the limelight one after another. Although not all of these have been defeated in the technology war, one should be on guard.

The nation's research organs must be discussed if we are to speak of nurturing talents. State and university research organs are accused of having practically no management consciousness and as a result, they are said to be incapable of conducting efficient research such as those seen in the civilian business sector. The pivotal factor is that we need to produce more researchers who understand the critical nature of their pursuits and who possess a spirit of mission in their search. We hope this will be realized.

Major Growth Industries

Tokyo NIHON KEIZAI SHIMBUN in Japanese 1 Jan 81 p 13

[Text] The configuration of star industries is shifting. Compared to the change that took place in the past--from fiber to iron, shipbuilding and further onto larger consumer assets such as automobiles and coolers--the baton change this time is conservative and the shift itself is not as yet too noticeable. Nevertheless during the 5-year period starting in 1981 the new stars are gradually coming forward. They are the technological revolution's aces--light electric appliance and general machinery that rode on the wave of the micro-computer revolution. Compared to the last 5 years during which unevenness was seen in terms of production growth rate, depending on the industry's adeptness in recovering from the first petroleum crisis, the characteristic of the next 5 years will be an even growth in every field--all of them revolving around the axis of processing and assembly industry.

What industry will demonstrate growth? Let us look at it from the demand perspective. During the 5-year period beginning in 1976, the largest growth sector other than stock-piling was export. The average annual growth rate was over 12 percent. The industry that fit well with this export expansion was the star industry. During the next 5 years, the export growth will shift to an average annual rate of 6 percent or so and the decline will be significant. In contrast, investment in civilian facilities and personal consumption goods is on the rise. Of course, the growth rate in these areas is not particularly large.

That is to say, from the demand angle, the ace industries for the next 5 years will be those not overly reliant on exportation and are indispensable as the focus of civilian businesses' capital investments and those that deal in personal consumption items.

How about the automobile industry that had been rapidly gaining in power? There will be some growth in the export volume but it does not have the vitality that it once had. Nor is the domestic demand likely to increase significantly. As a result, the automobile industry's average annual growth rate of 11.2 percent of the past 5 years will be held down to about 4.6 percent during the next 5 years. Its growth rate ranking among 36 industries will go from fifth (of the past 5 years) to 22nd (during the next 5 years). Rubber products (tires and so on) that were so favorably affected by the automobile growth will naturally experience a decline. We can say that the auto industry will move from a period of growth to a stable period. Textile, iron/steel, precision machinery--all these fields will see a decline in growth rate.

What industries, then, are slated to grow? It is difficult to spot an industry that will see a sudden growth in production. But if we look at the higher growth industries, we can gage certain trends. Light electric appliances and general machinery are the sectors said to have the tempo of quickest technological revolution. Heavy electric equipment, ceramics, quarrying, metal products, nonferrous metal primary production are supported by civilian investments.

Technological revolution in electronics related sectors resulting from the development of super-LSI (large scale integrated circuit) is remarkable. Technological revolution in general machinery, too, owes a great deal to developments in electronic technology, such as industrial robots, NC (numeric control) processing machine. Micro-computers are making inroads into homes and every aspect of industrial operations. Some have said that "super-LSI will replace steel as the new staff of industry." Deterioration of the automobile [industry] and precision instrument's growth rate and the rise of light electric appliances and general machinery to the top growth rankings indicates that the color bearers of the technological revolution are shifting from the mechanical to the electronics sector. Electronics plays an axial position in the technological revolution and technological revolution is the supportive pillar that enables industrial growth. If technological standard is at the very top, even though export volume may fall and domestic market conditions may cool, there is nothing to fear.

If we categorize industries into somewhat larger clusters and then look at the growth rate, it is clear that the over-all growth rate does average out. Growth rate in the processing/assembly industry in the past 5 years was 11.1 percent. The lowest was service industry at 3.6 percent and the difference between the two was 7.5. But during the 5 years beginning in 1981, the difference will shrink to 1.9. During the past 5 years, the processing/assembly industry alone demonstrated extraordinary strength. Now the mode will shift to a pattern where all the industries will show stable growth. In terms of industrial structure, processing/assembly industry will continue to be at the top but other sectors, too, will proceed along the growth path at a steady rate.

Japanese industry is about to come out of the two petroleum crises. The crises triggered the technological revolution. While the differences in growth rates among industries are being reduced, new leader-industries are beginning to emerge. Japanese industries are steadily developing--with technological revolution based capital investment by businesses and a desire to better the consumer life style as the chief propellants for the progress.

Table: Ranking by Domestic Production Growth Rate of Various Industries
(Average growth rate %, ▲ indicates minus)

Ranking	Category	1981-1985	1976-1980
1.	Light electric appliance	10.0	15.4
2.	Other manufacturing	9.7	10.7
3.	Heavy electrical equipment	9.5	11.7
4.	Other chemicals	9.0	12.4
5.	Manufactured metal goods	8.6	8.3
6.	Ceramics, quarrying	8.1	8.3
7.	General machinery	7.0	9.1
8.	Other service industries	7.0	4.3
9.	Primary nonferrous metal	6.9	10.2
10.	Primary iron/steel	6.9	7.9
11.	Precision machinery	6.8	22.0
12.	Construction	6.2	4.1
13.	Pulp/paper	5.9	5.8
14.	Foodstuff	5.7	4.5

[Table continued on following page]

15.	Commerce	5.7	6.0
16.	Printing/publishing	5.4	4.9
17.	Basic chemicals	5.4	7.4
18.	Electric power, city gas	5.3	6.0
19.	Transportation	5.2	5.0
20.	Other mining operations	5.0	5.1
21.	Financing/insurance	4.6	2.8
22.	Automobile	4.6	11.2
23.	Real estate	4.5	4.9
24.	Other transportation equipment	4.0	▲ 0.1
25.	Wood furniture	4.0	2.3
26.	Communication	3.3	2.8
27.	Agriculture/forestry/fishery	3.2	1.9
28.	Textile	2.9	2.0
29.	Community service	2.8	2.7
30.	Petroleum products	2.8	2.9
31.	Leather and leather goods	2.4	2.6
32.	Public service	1.9	5.2
33.	Coal products	1.7	▲ 0.3
34.	Rubber goods	1.6	6.2
35.	Pig iron/unrefined steel	1.4	2.5
36.	Crude oil, natural gas	▲ 0.7	▲ 2.3

VLSI Production Forecast

Tokyo NIHON KOGYO SHIMBUN in Japanese 20 Dec 80 p 7

[Text] Mitsui Bank (President: Masahiko Seki) completed a survey regarding trends in the major advanced technology fields and published its findings in the December issue of its monthly survey. The investigation dealt with seven technologies slated for commercialization in the 1980's--such as super LSI (large scale integrated circuit), laser and so on--and analyzed them with respect to future prospects and the development topics they entail.

According to this report, (1) production of super-LSI which at present comprises less than 1 percent of the 630 billion yen per annum semi-conductor market (domestic production base) is expected to reach 500 billion yen in 1985 and 1 trillion yen by 1990; (2) laser's current market is 5.6 billion yen per year. This is expected to reach 550 billion to 750 billion yen; (3) genetic engineering is still at the research stage. Compared to Europe and the United States, Japanese research in this field is lagging behind, and it was pointed out that foreign patent monopoly is a factor of concern.

Aside from these, the survey dealt with new ceramics, C_1 chemistry (chemistry using a compound which contains just one carbon atom), nuclear reactor energy and new energy. Among these, new ceramics is thought to have bright prospects. Nuclear energy and new energy developments are of great importance and necessity. But these topics contain many issues that need to be resolved before further progress can take place. Foremost among them is the formation of public accord regarding nuclear reactor energy utilization.

One of the causes of low economic growth--aside from such structural causes as energy restriction, inflation and the currency structure--is stagnation in the technological revolution. At the same time, for financial institutions, advance and priority financing of major technologies that have the potential of overcoming this stagnation is becoming an important decision-making guideline together with resource projects. This survey was an attempt to illuminate and explain the advanced technology fields by appraising the above noted circumstances.

Machinery Production Increase Projected

Tokyo DENKI SHIMBUN in Japanese 25 Dec 80 p 3

> [Text] On 24 December Japan Machinery Industry Federation published "Machinery Industry's Interim Demand Survey." According to the report, machinery industry's production volume for 1985 is expected to reach 56,311.4 billion yen. Average annual growth rate from 1979 to 1985 is predicted at 6.3 percent. According to the mining industry's production index, the average annual growth rate starting in 1979 is 5.1 percent. The machinery industry is slated to have a 1.2 percent increase. Compared to other industries, the machinery field will assume an even more central role in shouldering the Japanese economy in the future. Moreover, the electric machinery production figure is predicted to be 19,035 billion yen in 1985 with a steady annual growth rate of 8.4 percent during 1979-1985. The Federation explained that significant increase is expected in power generators, communication equipment, applied electronic equipment and VTR.

The said survey used 10-year chronological data from 1970 to 1979. It relied on the economic balance of the government's "Seven Year Plan for New Economy and Society" as its premise. Prediction was made for each machinery category (general machinery, electric machinery, transport machinery, precision machinery and others) using the correlated analysis method. The 1979 price was used as the standard.

The machinery industry's production for 1985 is forecast at 56,311.4 billion yen. From 1979 to 1985 the annual rate of increase should be 6.3 percent. Compared to the annual growth rate of 8.1 percent during 1973-1979, the rate of growth is somewhat slower. The Federation explains that at present, capital equipment investment and export which is enabling a favorable market climate is making the shift go smoothly. However, there are numerous troublesome issues including trade frictions and future industrial activity must face severe restrictions.

Domestic demand is expected to be 35,147 billion yen with an annual growth rate of 6.1 percent. This category's growth rate will surpass the annual average figure for 1973-1979 (4.8 percent). This is thought to be caused by the shift to a domestic demand centered economic growth pattern which will mean employment suitable for the post-petroleum crisis market, correction of imbalance in various economic sectors--international balance, public finance receipts and disbursements and employment.

Foreign demand will be 21,164.4 billion yen--an annual growth rate of 6.7 percent. Compared to 16.2 percent average annual growth rate during 1973-1979, the decline will be significant. The machinery industry will not rely heavily on exportation as it did before. Orderly export "behavior" will be encouraged.

On the other hand, the electric machinery sector will produce 19,035 billion yen. The 1979-1985 average annual growth rate will be 8.4 percent.

Domestic demand will reach 12,208.4 billion yen with an average annual growth rate of 8.3 percent. Compared to 3.5 percent for 1973-1979, it is a significant increase.

This is due to the fact that (1) during the metaphase, electric power need will grow at an annual rate of about 7 percent. Average annual growth rate for hydroelectric power development plan will be 6 percent. Power generator, stationary electric machinery, rotary power generator sectors are expected to have a 5-7 percent growth rate. (2) Communications equipment field will expand rapidly as a result of consolidation of data communications network and fusion of communication and computer technologies. (3) Applied electronics equipment which is the central figure in industrial development will grow steadily. (4) Demand for VTR, audio-equipment will rise suddenly as a result of cheaper prices, miniaturization and adoption of multi-functional format. (5) Electron tubes, semi-conductors, integrated circuitry which are the key ingredients for (4) are expected to grow at the rate of over 10 percent.

Foreign demand will reach 6,826.6 billion yen at a 8.7 percent growth rate. Though the rate will be half the growth rate of the past, continued 8-9 percent growth is anticipated in the future.

Electric machinery field forecast can be broken down as follows:

(Production)
Power generator--average annual growth rate of 7.5 percent, 621.6 billion yen. Rotary electric machinery--5.0 percent growth, 1,208 billion yen. Stationary electric machinery--7.0 percent, 1,954 billion yen. Communication equipment--9.2 percent, 1,486 billion yen. Applied electronics equipment--14.0 percent, 3,053.4 billion yen. Electronic calculator--8.1 percent, 310,740 billion yen. Electron tube, semi-conductor, integrated circuitry--12.1 percent, 1,955 billion yen. Battery 3.8 percent, 337.1 billion yen. Electronic communication system parts--10.2 percent, 2,129.4 billion yen. Electric machinery for public welfare--3.7 percent, 1,458.6 billion yen. Radio--0.5 percent, 93.6 billion yen. Television--4.3 percent 953.6 billion yen. VTR, audio-sound equipment--8.7 percent, 2,458.9 billion yen. Light bulb, lighting equipment--6.1 percent, 831.3 billion yen.

(Domestic Demand)
Power generator--7.0 percent growth, 325.5 billion yen. Rotary electric machinery--5.0 percent, 830 billion yen. Stationary electric machinery--6.6 percent, 1,384.4 billion yen. Communication equipment--8.6 percent, 1,163 billion yen. Applied electronics equipment--13.2 percent, 2,642.1 billion yen. Electric calculator--7.0 percent, 317.4 billion yen. Electron tube, semi-conductor, integrated circuitry--11.4 percent, 1,258 billion yen. Batteries--3.7 percent, 274.2 billion yen. Electronic communications equipment parts--10.1 percent, 700.7 billion yen. Electric machinery for public welfare--3.1 percent, 1,206.7 billion yen. Radio--3.7 percent growth, 41.6 billion yen. Television--3.1 percent, 518.1 billion yen. VTR, audio-sound equipment--17.1 percent, 629.5 billion yen. Light bulb, lighting equipment--5.6 percent, 717.2 billion yen.

(Export)
Power generator--8.0 growth, 296.1 billion yen. Rotary electric machinery--5.2 percent, 378 billion yen. Stationary electric machinery--8.0 percent, 569.6 billion yen. Communication equipment--11.5 percent, 323 billion yen. Applied electronics equipment--20.3 percent, 411.3 billion yen. Electric calculator--10.0 percent, 177.1 billion yen. Electron tube, semi-conductor, integrated circuitry--13.4 percent, 697 billion yen. Battery--4.0 percent, 62.9 billion yen. Electronic communication equipment parts--10.2 percent, 1,228.7 billion yen. Electric machinery for public welfare--7.3 percent, 251.9 billion yen. Radio--1.7 percent decrease, 52 billion yen. Television--5.9 percent, 435.5 billion yen. VTR, audio-sound equipment--6.6 percent, 1,829.4 billion yen. Light bulb, lighting equipment--9.2 percent, 114.1 billion yen.

Photo-Optic Technology

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 29 Dec 80 p 2

[Text] In order to formalize development of photo-optic technology, the Ministry of International Trade and Industry (MITI) has re-vamped the research/development format of a large scale project--"Applied Photo-optic Measurement and Control System" which was launched in 1979 and a new "Photo-optic Measurement Technology Research Union" (temporary name) will be formed anew in January in accordance with the Mining and Manufacturing Technology Association statutes. To date the prospective members for the said research union are as follows: Nippon Electric Company, Limited, Fujitsu Limited, Hitachi, Ltd., Toshiba, Mitsubishi Electric Corporation, Furukawa Electric Co., Ltd., Sumitomo Electric Industries, Ltd. and the Association for Promotion of Photo-optic Technology. Establishment of a cooperative research laboratory under the stewardship of the new union is the direction being studied. The pace of photo-optic technology development is expected to increase its speed with the formation of the new union.

Seven Firms (Nippon Electric etc.) and One Association Are Candidates

Applied photo-optic measurement/control system began in 1979 as one of the Industrial Technology Agency's large scale project. A budget of 51 million yen for 1979 and 927 million yen for 1980 have been appropriated. The scope of the project includes image information which originates at a given location, such as within an industrial complex or a large plant. The aim of the project is to measure such processing information as temperature, pressure, flow volume, components, using photo-optics under difficult conditions—presence of electromagnetic induction or combustible gas--and to develop a practical technology for transmitting and controlling the data.

In concrete terms, the project's goals involve direct transmission of image, high quality image transmission and information transmission to over 20 terminals, simultaneous transmission of multiple data types, high-speed information management and so on. The project will take 8 years and approximately 18 billion yen is to be invested in it.

The 1981 budget, though it did not reach the amount asked, was unofficially indicated as close to 2 billion yen and the MITI seized this opportunity to formalize the photo-optics research/development.

Up until now the Industrial Technology Agency was consigning research development topics, one at a time, to individual manufacturers. With the organization of a new technological research union, the same union will assume a key role in promoting research/development in the future.

With respect to the membership in this research body, it is anticipated that (the above named) seven firms, including Nippon Electric and one association will be the initial participants but there is fluidity in the format. There is a suggestion to first of all, limit the initial membership to seven firms and one association and thereafter add new members as research/development unfolds.

In any event, there will be a shift in format. Instead of the state (Industrial Technology Agency) commissioning research to individual companies directly, the state will commission the research union.

Photo-optic technology is expected to enter an actual utilization stage during the mid-80's and the 90's. It is seen as an emerging new industry with a bright future. The electronics industry is the most eager suitor of the photo-optic technology. Chief photo-optic manufacturers are large electron, electric machinery makers and electric wire producers. In recent years, glass producers and chemical manufacturers are showing great interest in the photo-optics market trends and the photo-optics "boom" is currently in the making.

While promoting the large-scale "photo-optic system" project, the MITI is putting great emphasis on promoting the development of photo-optics industry at the same time. To this end, it has organized the Photo-optics Industry Technological Advancement Association (President: Hiroshi Kobayashi, Nippon Electric Chairman) which united the photo-optics related manufacturers during the summer of 1980.

The establishment of a research union and a cooperative research laboratory discussed here is an aspect of this policy reinforcement.

Future Direction Suggested

Tokyo NIHON KEIZAI SHIMBUN in Japanese 3 Jan 81 p 6

[Text] Fine ceramics, high-efficiency molecular material, super-engineering plastic, super-alloy. The industrial world has become a competition arena for these previously unheard of new materials, their development and commercialization. Many are still at the basic research phase, and they are future technologies, but the majority are expected to go into the formal utilization phase in the 80's and 90's and thus, businesses cannot afford to have a late start in this development race. If Japan lags behind the West in new materials development, our international competitive strength in the leading basic industries--automobile, electric appliance, machinery and nuclear power--will be greatly curtailed. This is a development topic that resource poor Japan--which nonetheless seeks to become technologically independent--cannot ignore.

Industrial System Will Be Revolutionized

Fine ceramics is called the "Number 3 Material" after metal and plastic. Non-oxidation fine ceramics which artificially combines nitride, carbide and alike has conquered the frailty of traditional ceramics and is noted as resource-saving and energy saving new material which can override metal's functional limitations. It is expected to have a wide range of application as a highly processable industrial material in the future--including automobile engines and gas turbines for power generator. Some have called the late 90's, the expected time frame for its actual utilization, as the "New Stone Age."

In the instances of engines and turbines, the higher the temperature, the higher the thermal efficiency and the shorter the processing time. Metals can withstand only up to 1,000° Centigrade. Fine ceramics which is super-strong and which can withstand sudden temperature changes can break through this metal barrier. Moreover, cooling is not necessary. Unlike metal, it is non-corrosive. Its raw material is the earth's most abundant inorganic substance.

Japan's fine ceramics research development is still confined to the research laboratories of public research organs, universities and businesses. But the businesses are beginning to have confidence in its future and are starting to move toward utilization. Asahi Glass Industry Co., Ltd. has declared its intent to develop "non-pressure sintered nitric silicon and carbonic silicon." Showa Denko KK is striving to produce cubic crystal nitric borium--noted as a cutting and grinding material to supplant imported goods. Abe Industries, Ltd. is planning to establish a pilot plant for production of nitric silicon powder during 1980.

Tokyo Shibaura Electric which through independent technology succeeded in synthesizing high quality nitric silicon powder is focusing its present development goal on an automobile engine material. Its strategy is to "bring about utilization in some Diesel engine manufacture by the latter half of the 80's to be followed by development of gas turbine wing for a generator. (Materials Headquarters)

High efficiency molecular material is in plain language, "plastic with new capabilities." As with fine ceramics, this is an advanced technology that the industrial world--especially the synthetic fiber and the chemical sectors--are rushing to develop with goals set for the 90's. Ti, too, is a revolutionary new material.

Current development topics include high molecular substance that can conduct electricity as do copper and aluminum wires, selective transmittance film which can separate matter--for instance, extract only oxygen from air, high molecular substance that can withstand harsh use as do metal materials and so on. If these high molecular materials can become actually usable, electric wire and automobile weight can be substantially decreased. The chemical industry's separation/refining/reaction process will change completely, and a gigantic plant complex can be supplanted by a simple facility; and of course, great progress toward energy conservation can be expected.

Chemical Industry Tries to Catch Up to Synthetic Fiber Industry

This sounds like a dream story still but Toray Industries Inc. which is the vanguard of progressive group, proclaimed that "the time has come to begin entrepreneurial plans." (Chief of Real Technology Data Room, Sawano). Let us take, for instance, a high molecular electric conductor. In university laboratories promising new types are beginning to emerge. Sawano states that "even in terms of business operation, experimental products can be introduced from about 1985, and starting in 1988 we can start building it into an industry."

"There is also a high efficiency separator film which when completed, will remove distillation tower (separates matter by heating/cooling process) from chemical combinart." In order to accomplish this, we need to have a far more sophisticated membrane than artificial kidney and salt water/fresh water film. Polyamide materials are thought to be appropriate substances. The synthetic fiber industry is quite challenged. "This is the advanced technology on the same continuum as fiber and film and quite in our domain." (Toray, Asahi Chemical)

The chemical industry, too, predicts that high molecular technology will move rapidly in the ensuing 10 years (Mitsubishi Chemical Industries Ltd. Executive Director Shiro Kunugihara)" and it hopes to "catch up with the synthetic fiber manufacturers who are ahead." Asahi Glass which proclaims that it has the world's highest standard in ion exchange film, fluorine resin technology is seeking "to develop a separator film from fluorine resin film within the next 10 years" under its middle to long-range development project.

As for high molecular substance which can withstand harsh treatment, engineering plastic such as polyamide, polyacetyl have already made their appearance and because of their special properties--hard surface, high heat resistance, noncombustibility--they are used as parts in automobiles, home electric appliances and office equipment construction.

Close on the heels of U.S. firms--DuPont, G.E. (General Electric) and Celanese (foreign capital enterprises)--Toray, Teijin Limited, Mitsubishi Chemical Industries Ltd., Sumitomo Chemical Co., Ltd., Japan's major synthetic fiber and chemical firms are joining the rank of those hurrying to develop "super-ENPLA [engineering plastic]" which will have even more superior capabilities (than an ordinary engineering plastic) and which will replace metal substances. Among the revolutionary materials--the so called high molecular engineering substance and compound--"ENPLA" is said to be closest to the practical utilization stage; and it is expected that usage development and materials development in this field will advance rapidly in the future.

The materials revolution is predicted to gather momentum in the next 10 years. But compared to the United States, Japan's new materials development has had a late start. For example, U.S. Ford Motor Company's test production of fine ceramics based gas turbine car became news 3 years ago. DuPont Company introduced its first engineering plastic--called "challenge to the steel"--to the world 20 years or so ago.

Cooperation Between Government, Industry and University Is the Key

With regard to development of ceramics engine, Toshiba points out that, "in the United States, the value will be placed not on the cost-reduction factor so much but on the militarily strategic feature of dispensing with the cooling mechanism --that is, its advantage in military truck construction." (Metal Materials Section Engineering Chief Shogo Shimizu) In other words, the United States has a strong commercial/military union format. Toyota Motor Company Chairman Shohachi Hanai comments that "although U.S.-Japan role reversal is talked about, we should not underestimate the United States' middle and long-range strength." The reason for this is that in terms of advanced, revolutionary technology development capability, the difference between the two countries is very wide.

The MITI has initiated the "Basic Technological Research/Development System for Industries of the Next Period" spanning a 10-year period starting in 1981. The major themes to be dealt with under this system would be new materials--fine ceramics, high molecular engineering substance and so on. This is a national endeavor so that we can catch up to and surpass the technological level of Europe and the United States. The related civilian industries have organized a "Fine Ceramics Conversazione" (Chairman: Toshiba Vice President Fujio Tanatsugi) and a "High Molecular Engineering Substance Council" (Chairman: Toray Vice President Shoju Ito). Both government and civilian sectors have begun putting their muscle into the promotion of materials revolution.

Can the government, industry and academic world cooperate and promote efficient and effective research development? The key to the smooth evolution of Japan's materials revolution can perhaps be found here.

Series of Single Shots for Cumulative Gain

(Asahi Glass Director: Shiro Takahashi speaks)

Although fine ceramics does have wide range of applicability as industrial material, it is far too early to aim for such "home runs" as automobile engine or gas turbine for power generator. We must, first of all, go for more modest one-base hits and second base hits and build up. Asahi Glass began with commercialization of glass producing furnace materials and developed heat resistant ceramics as an industry. We intend to pursue along the same line and put our muscle into non-oxidation fine ceramics. Non-pressure sintered nitric silicon and carbide silicon based, super-strong ceramics were our first shots. These are being experimentarily used in steel, electric equipment and machinery industries already. We will increase our product line with a view to energy conservation. The growth rate each year is anticipated to be three to four times the previous year.

Ferro-alloy Industry Faces International Competition

Tokyo NIKKAN KOGYO SHIMBUN in Japanese 20 Dec 80 p 1

[Text] On 19 December the MITI disclosed that in order to determine the middle and long-range perspective of the ferro-alloy industry which is currently suffering from international competition as a result of a rise in power cost and increased importation of manufactured goods, it will establish an Association for Studying the International Policy for the Ferro-alloy Manufacturing Industry (a private inquiry organ reporting to the Basic Industry Bureau Director) during January of next year and to hold its first meeting then. The said association will be made up of the ferro-alloy industry, blast furnace and special steel manufacturers, commercial firms, financial organs and scholars experienced in the field. The subcommittees will deal with ferrosilicon, ferrochrome and the electric power questions. The MITI believes that a certain volume of ferro-alloy which has an important function as an accessory steel production raw material must be provided for domestically for economic security reasons. It, therefore, seeks to (1) wrestle with the electric power question, (2) research the means to efficient production, (3) establish energy saving policies, (4) deal with the overseas base, and (5) forecast the middle and long-range supply/demand situation during the next 2-year period. By the summer of next year, an interim report is to be written.

Research Group to Consist of Blast Furnace Makers, Commercial Firms, Etc. Interim Report Expected in the Summer

The ferro-alloy industry--ferrosilicon, ferrochrome, ferronickel, ferro-manganese and so on--received a devastating blow by the power rate increase of April this year. In addition, importation of cheap overseas products, mainly chrome, and the decline of demand resulting from declining production of steel has led to drastic weakening of Japan's international competitive strength in this field. The MITI ruled that a stable supply of ferro-alloy is indispensable to the mainstay industry--steel production--and that the domestic manufacturers must have operational stability. Therefore, it has decided to examine the situation in terms of a 10-year middle to long-range perspective and to establish an international policy study association to implement the plan. In the beginning, the plan was to be implemented before the end of the year, but there was delay in obtaining the response from the industry and January establishment was finally agreed upon.

The said association's members will be recruited from a wide field of industries. The chairman is slated to be a representative of the financial organ. Tentatively there will be three subcommittees. One of these, the power question subcommittee, will make an incisive study of the electric power question which greatly affects the ferro-alloy manufacturing cost. Such issues as a possibility of a government authorized rate and increasing the volume of privately generated electric power will be examined. Ferrosilicon and ferrochrome will each have a subcommittee, as well. In the case of ferrochrome, while annual domestic production is approximately 350,000 tons the import volume is 250,000 tons--that is, 45 percent of domestic consumption is dependent on imports and the import pressure is high. In the case of ferrosilicon, domestic production is approximately 320,000 tons and import volume is 130,000 tons--30 percent of domestic consumption is imported. This, too, is a high percentage. These imports are cheap and they are a blow to the domestic manufacturers and an accommodation measure will be sought. The subcommittees, at least initially, will be formed around these three problems. Ferromanganese and ferronickel will be dealt with in the same manner by the by.

In addition the said association will also investigate the most efficient domestic production format--possibility of intensification. Aside from that, in the sphere of overseas base issue, raw material acquisition policy will be part of the investigation as well. In establishing the said association, the MITI stated that, "it is necessary to secure a given volume of ferro-alloy production in order to assist national security. Using this as a prerequisite, the study association will investigate the future course of action." (Basic Industry Bureau, Steel Manufacturing Division) The outcome is worthy of our close attention. In preparation for the launching of the said association, the ferro-alloy industry--Nippon Kenko Co., Ltd., Japan Metals and Chemicals Co., Ltd., Shimura Kako Co., Ltd., Pacific Metals Co., Ltd., Showa Denko KK, Nippon Kokan Kabushiki Kaisha and so on--are hurrying with their response.

Industrial Robot Demand To Increase

Tokyo DENPA SHIMBUN in Japanese 25 Dec 80 p 9

[Text] The key element in the automation field--both in terms of technology and facility--is an industrial robot. This year is said to be "Diffusion Year One" and many are interested in its growth. According to the disclosure made by the Japan

Industrial Robot Industry Association (Chairman: Tsuneo Ando), total demand for industrial robot for 1980 is expected to reach 65 billion yen. During the 80's the annual growth rate of 21-25 percent (average) is anticipated.

Japan is said to be the world's foremost regarding use of industrial robots. It is estimated that as of 1980, we have 75,000 units. The major users are: automobile industry (40 percent), electric equipment industry (20 percent) and these two sectors together employ over 60 percent of all the industrial robots in Japan.

Examination of robot types reveal that at present, fixed/variable sequence robots comprise the majority with 45,760 units. Manual manipulator number 7,290; playback robot/numerical robot, 2,410 and intelligent robot, 1,340 (estimates). As the technological revolution progresses at a rapid pace, the relative importance of variable sequence, playback and intelligent robots will increase.

It is looked upon as a solution for the industrial world's current obstacles: energy conservation, power conservation, improved labor environment, pursuit of safety, insufficient labor force because the workers are older and better educated.

Meanwhile production of self-controlled robot is another area of high activity. Of late half the robot users are employing multi-use and self-controlled robots. This fact indicates that the choice of manufactured goods in the robot market is not wide. Development of robots that matches the user needs is not only desired in the future, but it also holds the greatest potential for the robot industry's expansion.

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SCIENCE AND TECHNOLOGY

NEW POLICIES TO PROMOTE SCIENCE, TECHNOLOGY REVIEWED

Authority of Council Expanded

Tokyo NIHON KEIZAI SHIMBUN in Janpanese 10 Jan 81 p 1

[Text] The government has set a policy to greatly strengthen and expand the authority of the Science and Technology Council, the highest deliberative organ for science and technology policy (chairman, Prime Minister Suzuki). By strengthening the comprehensive coordinating function of the council, the government aims at reforms which will give unity to the separate science and technology measures of the various ministries. A proposed amendment to the "Science and Technology Council Establishment Act" will be presented soon to the present regular session of the Diet and will include the following: (1) Discretionary executive authority over the science and technology development coordination budget shall be granted to the council, which previously served mostly as an advisory organ for the prime minister, and (2) the minister of international trade and industry, the minister of agriculture, and the chief cabinet secretary will be added as regular members of the council, which is now made up of 11 members, including the prime minister.

Since Japan must depend on imports from foreign countries for most of its resources, energy, and food, scientific and technological development is a very important concern. However, previous administration of science and technology has been dispersed throughout the various ministries and there has been little horizontal communication. Inefficiency has resulted from unclear policy concepts, and there has been criticism of the lack of an overall coordinating function. Therefore, last October, the government established the Science and Technology Cabinet Liaison Committee composed of severn cabinet ministers--from Finance, Education, Agriculture, Forestry, and Fisheries, MITI, the Economic Planning Agency, and the Science and Technology Agency, with the director general of the prime minister's office, Nakayama, as chairman, and made a thoroughgoing review of science and technology policy. Last December, this liaison committee prepared a final report, including a recommendation to "strengthen the authority of the Science and Technology Council," and presented it to Prime Minister Suzuki.

There is a rising tide of opinion which seeks reevaluation and strengthening of current science and technology policy. For example, in the budget outline for 1981 determined at the end of last year, the LDP included "development of science and technology and cultivation of leader industries for the next period" as a major policy for priority budgeting and loans and investment of public funds. The prime minister accepted this, and as a first step made a special allocation of 3.35 billion yen as

"Science and Technology Development Coordination Expenses" in the 1981 government proposal and arranged it so the Science and Technology Council could use this money freely. Also, in the regular meeting of the Science and Technology Council scheduled for February, 3 cabinet ministers--the ministers of international trade and industry and agriculture, forestry, and fisheries and the chief cabinet secretary--will be added as temporary council members by appointment of the chairman (the prime minister), and a special budget category of over 50 billion yen is being considered for "Science and Technology Development Coordinating Expenses" from 1982 on.

The Science and Technology Council was established in 1959 for the purpose of "establishing basic and comprehensive policies concerning general science and technology." The council members include the prime minister, serving as chairman, 4 cabinet ministers, the chairman of the Science Council of Japan, and 5 private citizens with special knowledge and experience, for a total of 11. Also, representative Japanese scholars and scientists serve as specialist committee members on six subcommittees. Even though this is the highest deliberative organ in Japan for determining science and technology policy, it has had the character of a mere advisory organ for the government, and has held regular meetings only twice a year.

Since it is difficult procedurally for the government to expand the authority of the Science and Technology Council by a decision of the chairman (the prime minister), it plans to quickly prepare and submit to the Diet a general revision of the establishment act for the council. The revision bill now under consideration by the government includes: (1) Moving the council administrative office from the Planning Bureau of the Science and Technology Agency to the chief cabinet secretary's office, and (2) establishing new operating committees in the related ministries and agencies to determine the use of the "Science and Technology Development Coordination Expenses" which can be used freely by the council.

Scalpel Taken to Administrative Obstacles

Commentary--The reform of the Japanese research and development organization which has been debated since last year has begun to make great progress toward materialization. The policy of strengthening and expanding the Science and Technology Council is a decisive action for the reform of science and technology administration, which previously tended to be neglected.

This council was created for comprehensive promotion of science and technology policies. But from the time of inception, the process of debate was hindered by a struggle for influence between the ministries and agencies involved, and although the members were all very prominent people, the council became an organization set up "above the clouds" without actual authority or leadership capacity. Therefore, the basic science and technology policies put out by the council had a character of being rounded off and compromised so they would not infringe on the aurhority of any of the ministries and agencies, and it was impossible to push ahead vigorously with the administration of science and technology on the basis of independent judgment. Among the almost 80 national testing and research organs there are many organs which seem to have completed the performance of their original function. From the viewpoint of making research and development more efficient, it may be felt that resolute merging or abolishing of some organizations is necessary without regard to the divisions between the various ministries and agencies. But in reality, the battles for power between the ministries and agencies prevent adequate debate or discussion.

The same problem occurs in research and development projects. The Science and Technology Agency exists as an overall coordinating agency for science and technology, but its main energies are directed toward promotion of individual big projects of the agency in such areas as atomic power, space, and the oceans. The budget for research and development which crosses over lines between ministries and agencies (Special Research Promotion Coordination Expenses) is an annual total of several billion yen, not even 1 percent of the agency's total budget. Research and development projects are often left up to individual ministries or agencies, and the science and technology budget is not being used very efficiently.

The strengthening and expansion of the Science and Technology Council is aimed at a basic solution of this problem. However, the adjustment of differing views on the changes in the council organization is not yet complete. The Science and Technology Agency, where the office of the council is now located, says that decisions should be made after observing future developments, such as how the Science and Research Council handles the science and research development coordination budget and whether the present organ can function well as is.

In particular, if the office is to be moved to the chief cabinet secretary's office, there is a possibility that the Science and Technology Agency itself may be dissolved, going beyond just a revision of the law. A rather large research capability must be established in the office, and this would not mean only moving in most of the Science and Technology Agency. It would also absorb the departments which prepare proposals for technology policy from other ministries and agencies. It is a question of whether it would be appropriate to set up such a function in the chief cabinet secretary's office. According to the situation, it may be necessary to create a "second Science and Technology Agency." In any case, prudent study is called for to prevent a reoccurrence of what happened when the present council was set up.

Corporation Aids Manufacturing Technology

Tokyo NIHON KOGYO SHIMBUN in Japanese 29 Dec 80 p 3

[Text] The New Technology Development Corporation (Yoshimitsu Takeyasu, director) has recently instituted a new system, the "technology processing system," to transform the research results into technology. The aim of this system is to change academic research results into technology, product technology that can be used immediately by smaller enterprises and regional enterprises lacing in technological capacity. As the first project, the corporation commissioned the inventors Professor Kazuo Fushimi of Tokyo University and Assistant Professor Tadaomi Nishikubo of Kanagawa University to further refine the technology for a radiation position detector and a self-sensitizing photosensitive plastic film. In January it is also planned to commission Professor Mitsuaki Mukoyama of Tokyo University to further develop his "catalyst for asymmetric synthesis and application technology." The corporation plans to have the processing finished by the end of March, seek out a manufacturer to commercialize the technology, and make arrangements for its use.

The technooogy processing system was established because of the realization that although excellent results were produced by university and government research facilities, they were often difficult to use because the content was too academic or theoretical for commercialization and the rate of dissemination was limited.

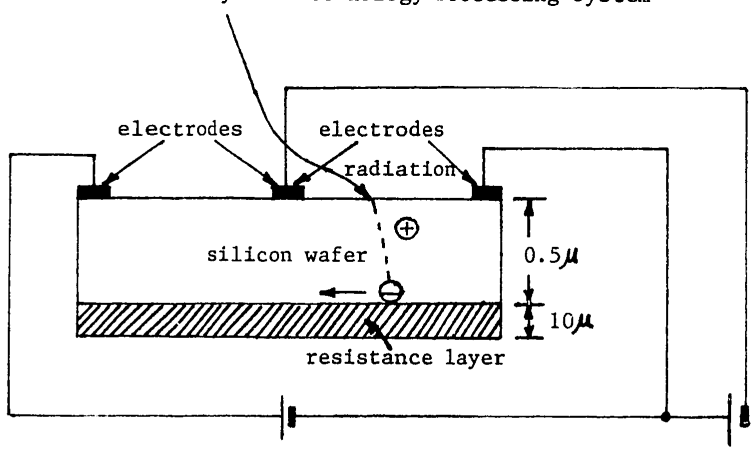
The New Technology Development Corporation is already carrying out a development consignment system for commercialization of research results involving a risk for industries with high technological capacity and a go-between system for introduction of highly finished technology. So far it has transferred research results to the private sector close to 400 times.

This new system aims at helping smaller enterprises with low technical capacity and regional enterprises with limited access to information by producing commercial-level technology, including practical application technology, and acting as intermediary between the source of the technology and the enterprises. The corporation has had an image of being merely an introducer of technological developments, so this first move to high-level processing of research results is attracting attention.

The two types of technology which have been commissioned are as follows.

Radiation Position Detector -- The corporation aims to expand the function of the silicon radiation detector invented by Professor Fushimi of the Tokyo University Nuclear Laboratory so that it will detect position.

Structure of the Radiation Position Detector
Handled by the Technology Processing System



The silicon radiation detector is composed of single crystal silicon formed with a uniform thickness and surface, a resistance layer formed by vapor deposition on the surface of the silicon, and electrodes attached to the silicon wafer as shown in the figure. When radiation strikes the silicon wafer, the holes and electrons inside the wafer undergo electrolytic dissociation and the resistance from the electrodes can be read. The electrons moving inside the wafer travel exactly along the borderline between the silicon and the resistance layer. The resistance layer is formed by vapor deposition and defects in the deposited film or roughness of the junction plane between the silicon and the resistance layer can occur and cause nonuniformity of the junction plane so only incidence of radiation can be detected. However, with precision fabrication, the incident position can be determined from the duration of electron movement. The vapor deposition method will be changed to a semiconductor fabrication method of vapor-phase epitaxial growth to produce a resistance layer with uniform thickness and surface. There are not many applications for a simple radiation detector, but if it is able to detect position it could be used as a radiation sensor in a variety of areas, such as nuclear physics experiments or in detecting the location of radiation leaks in medical equipment and nuclear reactors. Professor Fushimi has received 2.5 million yen in processing expense from the corporation.

Self-Sensitizing Photosensitive Resin Film -- This is a film technology newly developed by Assistant Professor Nishikubo of Kanagawa University. It uses a new type of photosensitive resin with a photosensitive radical incorporated in a side chain in the resin structure.

Conventional films include a photosensitive radical in the polymer products obtained by polymerization of vinyl monomers, but it is difficult to obtain uniform dispersion of the photosensitive radical and sensitivity is low. Therefore, a sensitizing agent is usually added.

With the new technology a photosensitive radical is added to a side chain so the photosensitive radical incorporated in the material is dispersed uniformly. It gives the same test results as the conventional film with a sensitizing agent added and has 10 times the sensitivity of the conventional film alone. If this processing is successful, it is expected that commercialization of the new film will be achieved ahead of the rest of the world. The film can be used in fabrication of minute elements of shadow masks, printed circuits, and printing plates. Assistant Professor Nishikubo has received 3.5 million yen in processing expenses.

Creative Science, Technology Budget

Tokyo NIHON KOGYO SHIMBUN in Japanese 29 Dec 80 p 3

[Text] The Creative Science and Technology Promotion System for which the Science and Technology Agency had requested a budget as its leading program for 1981 was barely approved in final ministerial negotiations. Furthermore, the approval was given only under the difficult condition of taking the money from the 3.35 billion yen newly allocated for 1981 for Science and Technology Development Coordination Expenses (tentative name).

This Creative Science and Technology Promotion System had the subtitle, "Aiming at Creation of Revolutionary Technology through a Flexible Research System." The objective is to search out and develop the seeds of new and revolutionary technology.

There was thought of applying 500 million yen to creative science (1.07 billion yen was requested) from the 3.35 billion yen newly allocated for Science and Technology Development Coordination Expenses. However, in this era of international competition, Japan must put effort into creative scientific research. The plan is to listen to the views of the Science and Technology Council and to invest close to the amount requested.

Research will begin in 1981 on all four research themes initially announced: the amicron, fine polymers, special structures of matter, and holohedral crystals (elements).

Early in 1981, four project managers will be chosen from among scientists working inside or outside Japan, and with the New Technology Development Corporation acting as coordinator, four projects will be started under these managers. The plan is to proceed with research and development aiming at a Nobel Prize.

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SCIENCE AND TECHNOLOGY

THREE-DIMENSIONAL CAD/CAM SYSTEM FOR MOLD, DIE DEVELOPED

Tokyo HITACHI HYORON in Japanese Vol 62, Jul 80 pp 27-30

[Article by Hirofumi Jonishi of the Central Laboratory, Hitachi Limited]

[Text] 1. Introduction

The development of products which match the needs of the times in short order and their production to bring them out to the market are important subjects in the products area where design is highly emphasized as is the case with the outer appearance of household electrical products and general use products. On the other hand, the outer appearance of this class of products is often a complex combination of freely curved surfaces, and the die making involves many difficulties. Die making in the past was almost entirely by profile finishing, but this practice entailed many difficulties with respect to precision, number of operations, and cost as a result of which there were great hopes that NC (numerical control) would alleviate such problems. On the other hand, the construction of a NC tape to be used in the finishing of a 3-dimensional shape of freely curved surfaces is no simple task. This system proposes to resolve the problem areas associated with methods of the past and has as its objective the production of dies in short time and with good precision by the use of computers. Where performance is concerned, this system is intended to support all the steps of CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) from design through NC finishing, but this system is presently being used principally in the CAM area where its effects are the greatest.

2. System Makeup

As illustrated in Fig 1, this system can be roughly divided into the three capabilities of 1) shape model constructing capability, 2) diagram drawing capability, and 3) NC tape making capability. Capability 1) involves the input of the 3-dimensional shape which is the subject in question into the computer to construct a numerical model (hereafter referred to as the shape model) of the shape within the computer as well as the placement of any corrections. The input process involves the use of the proper language, and a shape describing language for sole use with this system has been developed. At the same time, it is the general case that the diagram is the source for the introduction of principal information during the production process, and the sketches and design figures which the designers and planners have drawn up are thought to provide the diagram information which is the shape input source. This diagram can be a rough sketch as long as the necessary dimensions are accurately recorded. Where 2) is concerned, this is the capability by which the shape model created within the computer is converted into a 2-dimensional model, and perspectives, triplanar projection, and cross-section type shapes are outputted. This capability is used mainly for shape check and automated diagram drawing. 3) Is the capability for making NC tapes with the NC fabrication device to be used in production of discharge finishing electrodes or forming dies. As long as the finishing conditions such as cutter feed speed or cutting precision are indicated, this capability will calculate the tool usage pathway from the shape model within the computer and output the control commands through paper tape.

These various capabilities are presently being exploited with the Hitachi large computer HITAC M-180. The scale of the program is such that there is a total of about 60 k steps (almost entirely in FORTRAN), and the exclusive memory during program scanning is a maximum of 256 k bytes. At the same time, the connection of HITAC M-180 to a figure processing terminal HITAC G-730 to make a RJE (remote job entry), the calculation results can be immediately put out as a graphic display thereby making for more efficient input and output. The shape model construction capability and NC tape making capability which comprise the central technology of this system are described below.

3. Shape Model Construction Capability

As mentioned before, the sources of input are sketches and design figures type graphical information. These graphical representations have curves which characterize the 3-dimensional shape which are referred to as character lines or highlight lines. Consequently, by inputting these curves, it is possible to create a 3-dimensional shape skeletal model (wire frame model) within the computer. An example of a skeletal model of an electric cleaner in which the characteristic curves have been inputted is shown in Fig 2. Since there is need to establish the surface shape in order to represent the 3-dimensional shape in complete manner, curved planes are pasted on to this skeletal model to make the complete model. To this end, the region of section A in Fig 3 bounded by the curved lines is removed, and the curved plane is filled in using the peripheral curved line information at the different regions. At this time, the connecting sections of this synthesized curved plane with the peripheral sections must preserve the smoothness of the C^1 class.

The above is an outline of the method of constructing the shape models for this system. The important point here is that the area of this synthesized surface for filling in be as wide as possible within the limits that the intent of the design is satisfied because this enables reduction in the number of curved lines which make up the skeletal model and reduces the input into the shape. This system has developed an independent curved plane filling in method for this purpose. As illustrated in Fig 3, the basic principle is to deform and translate peripheral curves C_1 and C_2 along C_3 and C_4 to obtain a load average and create the curved surface. When a deformation translational operation is to be performed on a Coons curved plane [1], only a parallel translation is involved, but this mode also enables rotation, expansion, and contraction type linear conversions making possible increased space filling capability. In addition, the various deformation translational operation methods can be classified into a number of model types from which the user can choose freely in line with the intended design. This type of method was used to put on a curved plane which was then outputted with a bird's eye view diagram which is displayed in the examples of Fig 4 (a) and (b). An example in which the same type method was used to create a continuous cross-section is shown in Fig 5.

The above has been a discussion of shape model construction methods, and there is available a shape descriptive language solely for this purpose. In order to describe the makeup of 3-dimensional shape, this language is made up of the three fundamentals of 1) description and definition of curved lines, 2) description and definition of curved planes, and 3) joining designation of curved planes. The language is also provided with auxiliary capabilities and capability to operate the shape model which is constructed in order to facilitate this shape description. The structure of this shape description language is outlined in Fig 6. The inability to efficiently input the shape was the bottleneck of this type of system of the past, and the system described above has introduced considerable improvement as a result of which it has become possible to increase the effect of its application to actual production processes.

4. NC Tape Making Capability

This capability is used to output command paper tape for finishing recognition models, discharge finishing electrodes, and forming dies with NC tool machinery. The input data must include other than the shape model in the computer internal section the cutter feed speed, cutter diameter, and cutting precision type finishing conditions. In a technological sense, the resolution of the socalled problem of cutter interference such as the bite into the product by the cutter is important. As illustrated in Fig 7, cutter interference is generated at the section where a number of curved planes intersect. For example, should the cutter be moved along the curved plane in the manner shown in Fig 7, there will be generated a cut on the product surface only along the lines of the radial direction of the cutter. A provision must be made so that the cutter will stop cutting whenever it makes contact with a plane other than the plane it should cut in order to avoid this occurrence. The automatic observance of such a movement is called interference processing. The shape shown in Fig 7 is a very general case, and the human designation of the site where the cutter is to stop is practically impossible so that this capability is considered to be one which cannot be dispensed with. Some technological problems remain in the examination of interference between the product surface and the cutter. This problem can be resolved through rigorous solution by elementary analytics when the shape of the product plane is simple but becomes impossible by elementary analytics treatment when the surface in question is a free surface of the general type. When such is the case, there is no other approach but to rely on an approximate calculation. The method which usually comes to mind is that in which the product surface is approximated with a multiple plane approach or a method which makes use of the Newton method, but either approach involves practical problems with regard to the processing speed and precision involved. This is why this system developed the following method. First of all, the shape is divided and covered with simple shapes to check interference in order to understand interference regions in a macro sense. Repetitions of this method make possible narrowing down the regions where interference may occur in the same manner as the principle for the dichotomy [literal] method. Once the region of possible interference has been bracketed to a reasonably small area, a precise calculation is made employing a numerical method such as the Newton method. This method is a combination of both macro and micro techniques, and by the proper balance between the two types of techniques, high speed processing and high precision calculations are obtained. The tracks of a NC cutter calculated in this manner are shown in Fig 8. By the use of the method described above, it has become possible to prepare the desired NC tape of even a shape which is an assembly of very complex freely curved surfaces with the user being completely unaware of the difficulties involved.

5. Concluding Statements

A system has been developed which makes possible the production of complex 3-dimensional shapes such as those involved in forming dies in short time and with good precision. A NC tape produced with this system was used to form the metal die shown in Fig 9. Figure 10 is an example of a discharge finishing electrode which was produced in a similar manner. These are examples of parts for electrical cleaning machines. As illustrated in Fig 9 and Fig 10, the applications of this system at the present time are mainly in the area of plastic injection formed products for use with household electrical appliances, but the applications are thought capable of extension into the areas of press forming and aluminum die casting. Among the effects which can be realized are reduction in number of steps, improvement in precision, and associated economy in quantity of plastic material required. Problems for future resolution include 1) expansion in application area through promotion of efficiency in shape input, 2) development of simulation technology which is a combination of shape model production technology and the finite element method, and 3) compilation of a large scale data base which can handle a large number of shapes. We hope to involve ourselves in the solution of these problems.

Reference Cited

[1] Kenno: Automobile Design Methods, Corona Co. (Jul 1969).

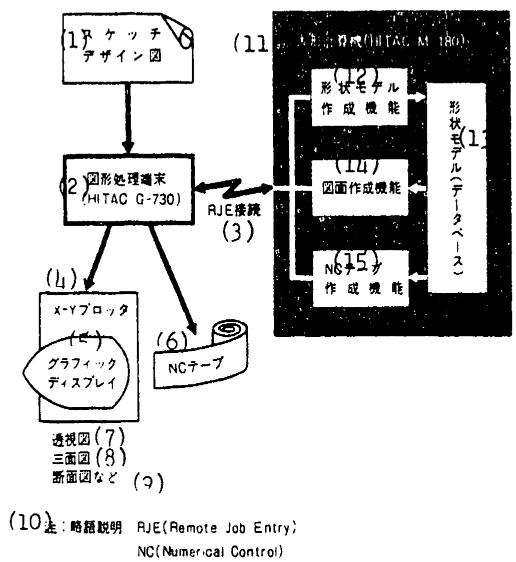

Figure 1. System Makeup

The main capabilities are vested in the large computer which can be used by itself, but an even better system of greater response can be obtained by connection to a figure processing terminal.

Key:

1. Sketch, design figure
2. Figure processing terminal
3. RJE connection
4. X-Y plotter
5. Graphic display
6. NC tape
7. Perspective diagram
8. Triplanar projection
9. Cross-section, etc.
10. Note: definition of abbreviations
11. Large computer (HITAC M-180)
12. Shape model making capability
13. Shape model (data base)
14. Diagram drawing capability
15. NC tape making capability

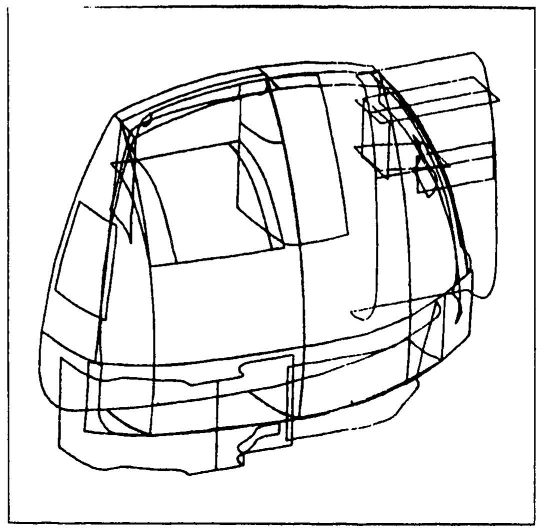

Figure 2. Skeletal Model of Electric Sweeper

A skeletal model is set up within the computer by inputting curves which define the characteristic features of the 3-dimensional shape.

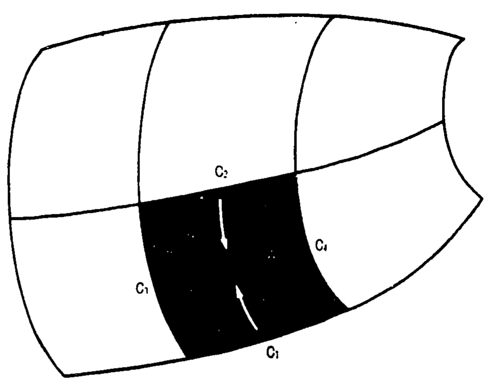

Figure 3. Curved Plane Filling-In Method

C_1 and C_2 are deformed and translated along C_3 and C_4 with load averaging to create curved surfaces.

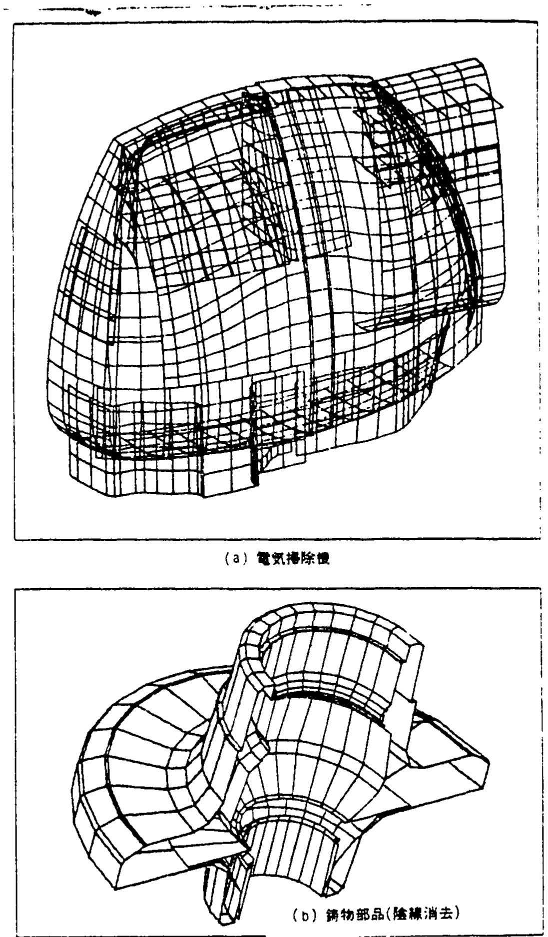

Figure 4. Birds Eye View

After placing the surface on to the skeletal model, the curved planes were reproduced by mesh representation.

Key:

a. Electric sweeper
b. Cast part (shading removed)

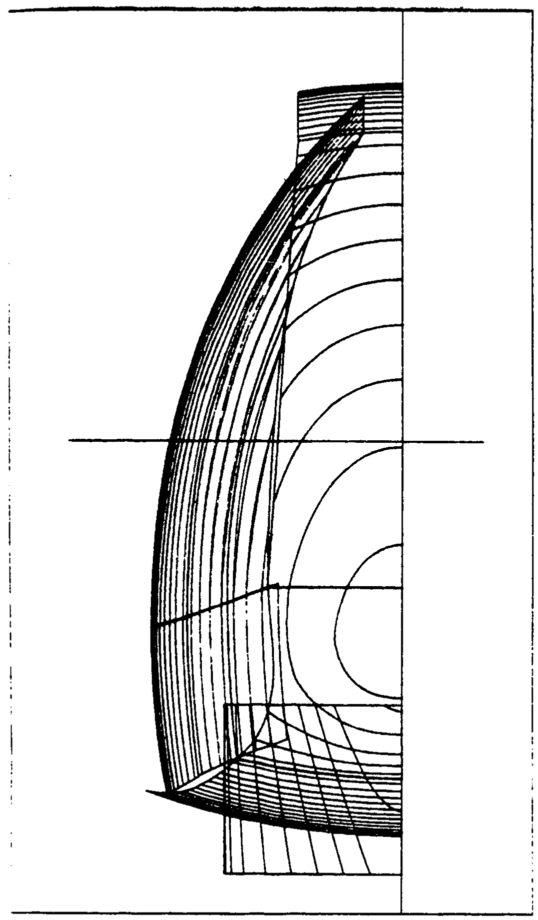

Figure 5. Cross-Section of Electric Sweeper

A cross-section of the left half of Fig 4(a) was reproduced at 5 mm pitch. This is used mainly for recognition of shape design.

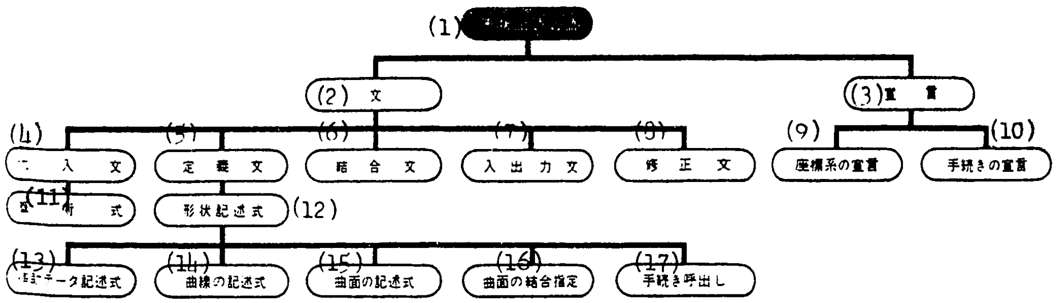

Figure 6. Makeup of Shape Description Language

Various commands are available for efficient input of skeletal model and creation of curved surfaces.

Key:

1. Shape description language
2. Text
3. Statement
4. Substitute word
5. Definitive word
6. Connecting word
7. Input-output words
8. Corrective word
9. Description of coordinate system
10. Statement of procedure
11. Arithmetic equation
12. Shape description formula
13. Auxiliary data description formula
14. Curve description formula
15. Curved plane description formula
16. Curved planes joining command
17. Procedure call out

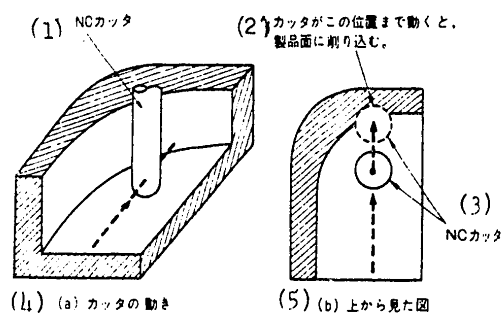

Figure 7. Example of Cutter Interference

In order to perform NC finishing of combinations of curved planes, the socalled cutter interference problem in which the cutter cuts into the product surface has to be resolved.

Key:

1. NC cutter
2. The cutter cuts into the product surface at this point
3. NC cutter
4. Cutter movement
5. View from the top

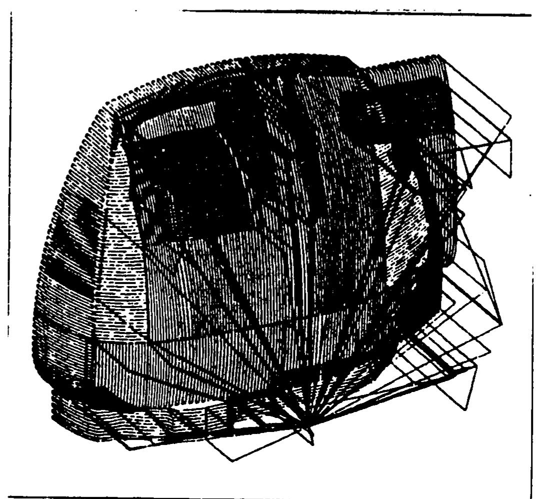

Figure 8. Example of Cutter Tracks

The movements of the NC cutter are calculated from the shape model in the computer and the finishing conditions, and the NC tape is produced.

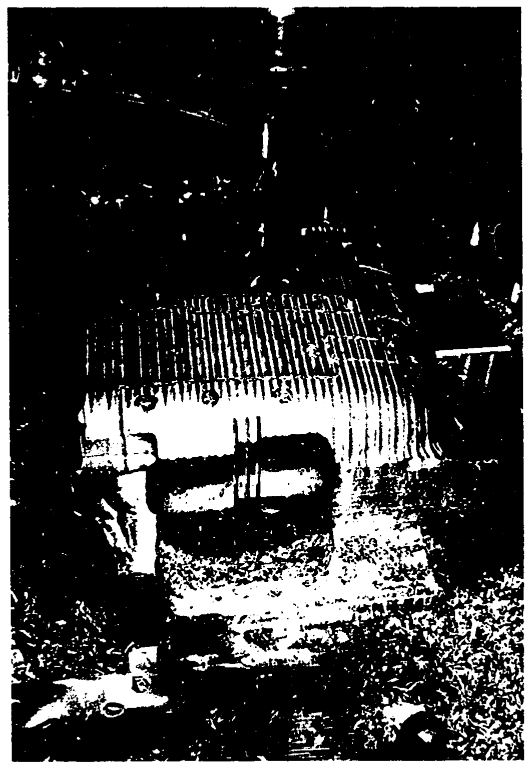

Figure 9. Metal Die Undergoing NC Finishing

A metal die is being finished using the NC tape produced by this system.

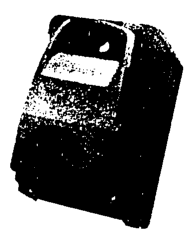

Figure 10. Discharge Finishing Electrode

Discharge finishing electrode finished with a NC tape produced by this system.

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SCIENCE AND TECHNOLOGY

BASIC SOFTWARE FOR COMPUTER AIDED DESIGN

Tokyo HITACHI HYORON in Japanese Vol 62, Jul 80 pp 31-36

[Article by Tsutomu Oguni and Haruo Kosaki of the Software Plant, Hitachi Limited]

[Text] 1. Introduction

There is a number of CAD present in the item which goes under the designation of CAD (Computer Aided Design). These can be roughly classified under the following four categories.

1) Mechanical family CAD such as for generators, refrigerators, automobiles, and constructions

2) Electrical family CAD such as for control panels and distribution lines

3) Electronics family CAD such as for printed circuits

4) CAD which is software oriented

This paper will touch on the fourth category of software oriented CAD and will be specifically concerned with the subject of basic software for CAD use. This type of CAD covers an extremely wide scope, and it is the common situation that it is used together with some other CAD. The CAD which makes up the software of the software oriented type can be of the following depending upon the application at hand.

1) Ring structure data processing program used in maintenance control of design data

2) Program group for structural analysis

3) Figure processing software for drawing design diagrams

4) Text editing and printing program for design description

5) Technological information search system for examples of accidents or experimental data

6) Software for conversational type statistical treatment program or budget compilation

7) Software for software engineering

The Hitachi general use HITAC M series computers are dedicated to the development of programs in these various areas, and these have been compiled in systematic manner. Among the items listed above which comprise the basic software, the ring structure data processing system of 1) and software for figure processing of 3) will be the main subjects of discussion here.

2. Software Oriented CAD

The classification of software for CAD use into its major subdivisions includes the group of software which serves as the basis of other CAD (direct design activity software) and the software (indirect design activity software) which is useful in computer processing auxiliary activities from the design activities area and rationalization of the design activities. The ring structure data processing system, the figure processing software, and the structural analysis program come under the first category while the text editing and printing program, technological information search system, conversational type statistical treatment program, operations and plans simulation program for budget compilation, and software for software engineering come under the latter category, and these are considered to comprise the scope of CAD.

2.1 Software for Direct Design Activities

Design activities are mainly concerned with maintenance management of design data, analysis of design data, and construction of design figures. "ARIS" (Associative Ring Image Structure: ring structure data processing system) is used in the maintenance and finishing of design data. Among the programs available for the analysis of design data are isoparametric elements based on "NASTRAN" (Finite Elements Method Program) of "NASA" (National Air and Space Administration of the United States) and the IG/OG (Comprehensive Structural Analysis Input-Output Program), "ISAS-POL" (Program Oriented Input Language Program), "MPLAREA II" (Cross-Sectional Properties Computation Program), and "TPLIG" (Conversational Type Input Analysis Program) which are centered in "ISAS II" (Comprehensive Structural Analysis System) which enables great improvement in capabilities and performance. All the programs for structural analysis available presently are listed in Table 1.

Although the primary purpose of CAD is to use the computer to construct design diagrams and compile design text, its basic software includes various X-Y plotters H-8844 (Hitachi storage type figure processing facility), H-8833 (Hitachi refresh type figure processing facility), and Kanji printer which can all be interphased and processed through a "GPSL" (Graphing Plotting Subprogram Library: general use figure output routine assembly). Programs related to GPSL are "VECTOR-FONT" and "DOT-FONT" (program for putting character font into conversational form) along with a figure output utility which outputs design commands to various figure outputting facilities. Among the several routines of GPSL, the business graph which is used for graphical representation of management information or experimental data can be outputted through "LINEPLOT" (line image figure making routine assembly) and displayed by a line printer or a CRT (Cathode Ray Tube: character display device). There is also "TONE" (Dark and Light Output Subroutine Assembly) which utilizes the features of a Kanji printer. Although GPSL is a general output subroutine assembly for output alone, the joint use of GPSL and "DEPP" (text editing and printing program) makes possible design text with figures to be printed in a Kanji printer. An overall view of the figure processing system is shown in Fig 2.

2.2 Software for Indirect Design Activities

The automation and rationalization of the socalled business activities and clean copy production become necessary if the designer is to conduct his designs smoothly. There are available "DEP" (Text Editing and Printing Program) for printing design text and instructions, "ORION" (Literature Search System for Search of Accidents and Damage Data), "SDFS II" (Statistical Data File System) for analysis of experimental data or operational data, and "CSTAT," "PPSSII," and "TIMES II" (Conversational Type Statistical Treatment Program). It is expected that the output file of conversational type statistical treatment program will be made capable of Kanji output by use of "STATEDIT" (Statistical Calculation Output Compilation Program).

"ORION" can store and search technical information in the form of character information or numerical information which has been put into conversational form, and it can also take subject numerical information obtained by a search to analysis by the conversational type statistical treatment program by way of the file. Another important design activity is budget compilation, and this function assumes considerable weight when the design activity has to bear the responsibility for profit-loss situations. "SIMPLAN" (Simulation Plan on Management Plan) is used for this purpose. These programs are organically tied together through the file.

3. "ARIS" (Ring Structure Data Processing System)

There is a popular trend to put shapes and properties of structural items in one swoop into a data base for management and to utilize this data base for shape modeling, structural analysis, and numerical control by a series of CAD/CAM (Computer Aided Design/Computer Aided Manufacturing) operations. It is possible to use a commercial data base system ADM (Adaptable Data Manager) or a PDM (Practical Data Manager) with this data base structure, but the problems of processing speed and operability accompanying design data structure point to the desirability of a data base system for engineering use.

The Hitachi HITAC M series general use computers were tied in from 2 years ago with the development of the associated ring structure based "ARIS," and this system has been put into practical use at the Suzuki Motor Company, Ltd. "ARIS" is a program written in PL/I (Programming Language/I) and possesses the following features.

1) Ease of constructing data structure

Since all data is presented by a ring structure tied together by ring pointers, any desired data structures can be readily constructed. There is no practical limit to the number of data which can make up the ring.

2) Versatility in data processing

The ring structure is comprised of a closed loop in which parent groups are the ring start, and data processing can be initiated from any position on this structure.

3) Ease of data operation

This system is a collection of subroutines which can be called out by the CALL text of FORTRAN, and the user can readily reference or revise the information in the data base simply by calling out the subroutine.

4) Improvement in system efficiency

Paginating capability, hashing [phonetic] chain technique, neighboring page utilizing capability, and maximum use of vacant space capability are provided enabling improvement in processing efficiency and storage efficiency.

The manner in which a tetrahedral data structure can be represented when "ARIS" is employed is illustrated in Fig 3. The various faces of this tetraheron give the color properties, names, and name display coordinates while the apices give the names and name display coordinates, and the various lines the line properties.

4. Figure Processing Software

The types of figure processing equipment have become particularly abundant during the recent years, and various Kanji printers, color display equipment, high quality keyboard printers, and digitizer coupled with simple plotter have made their appearance in addition to the figure display equipment of the past. These various figure display equipment are capable of employing user's FORTRAN programs and APL (A Programming Language: general conversational language), subroutines, and function type programs, however, the user interface differed with each equipment, and the type of subroutine group proposed with the figure display facility was limited to the most basic type. This was why there was a need for a more rich routine independent of the figure display facility, and "GPSL" was developed to fill this void.

[Apparent omission] a figure output utility group became necessary, and there are presently four types of programs. In addition, display of business graphs on a line printer and character display facility has become necessary, and a subroutine group "LINEPLOT" which makes this presentation on the same display using the same interphase with "GPSL" was developed. "VECTOR-FONT" and "DOT-FONT" which are programs constructed from character front file for use with "GPSL" and "DEPP" along with tablets and H-8844 have been developed for jig and tool use.

4.1 "GPSL" (General Figure Output Routine Group)

"GPSL" which was developed as basic software for figure processing was put into product form based on "GIPS/PLOT" (general graph making routine) of the Laboratory of Hitachi Limited, and it included 163 types of routines as of July 1980.

4.1.1 Purpose

There are the following five purposes for "GPSL."

1) User interface which is not dependent upon the figure display facility

2) Capabilities for geometric shapes, figure making, 3-dimensional treatment, and business

3) Filing of 2-dimensional figures and data

4) High level interchangeability with user's programs through Calcomp interphase

5) Figure display parts for standard applications

4.1.2 Features

"GPSL" is associated with the following features.

1) Figures can be drawn in different figure display facilities from the same user's program

2) Imaginary diagrams which are not dependent on the figure display device can be designated

3) Actual diagrams corresponding to the figure display device can be designated

4) Shapes and line types (solid lines, broken lines, dotted lines) can be isolated

5) The Hitachi Kanji code (16 ranks, 4 columns) and EBCDIK code can be used for the Kanji code and the Calcomp code can be used for the SYMBOL routine

6) Character types include numerals, Kanji (Toyo Kanji level), Hiragana, Katakana, Roman alphabet capitals, Roman alphabet lower case letters, and Greek characters

7) Figure data are filed away and can be used for finishing, photographing, or displaying

8) The names of routines were coded to avoid duplications with present user routines

One of the features of "GPSL" is the abundant introduction of business routines which display the results of statistical treatments, and a part of this is shown in Fig 4.

4.1.3 Figure Data

The figure data are processed with the figure data control routine through the basic section of "ARIS" which is incorporated into "ARIS." The figure data are comprised of four layers which are the element, part, layer, and diagram in ascending order, and names and shape independent properties can be applied to parts, layers, and diagrams. At the same time, line type or pen type directions can be applied to parts and layers. The definition of these figure data is given in Table 1.

Passwords are used with figure data files to protect their secrecy and guard against accidental corrections and breakdowns.

4.2 Shape Output Utility Assembly

The output command file for "GPSL" is the same as the commands for the CALCOMP plotter and will work with the CALCOMP Company or Hitachi Seiki Company plotters. There is a utility group which enables output of this command file through an on-line plotter, Kanji printer, and a H-8844. In addition, a utility group with programs to output "GPSL" commands through SYSOUT files and then output the file through plotters are also included.

4.2.1 Preview Program "PREVIEW"

While it may be said that high performance plotters have made their appearance, the drawing of figures with a plotter during a debugging process leaves much to be desired where efficiency is concerned. By inputting the command file and making the drawing with a H-8844, and outputting the command file on the plotter whenever the desired figure is thought to be represented will eliminate excessive efforts. "PREVIEW" not only draws a figure of the contents of the command file but also possesses the following capabilities.

1) Expansion, contraction of figures

2) Parallel translation of figures

3) Stacking of figures using imaginary figures

4.2.2 "OUTPLT" (Output Program for Plotter Use)

"OUTPLT" is a program for drawing the "GPSL" command file on an on-line plotter and possesses the following capabilities.

1) Display of job title, user's name, and execution time

2) Clipping processing

3) Output of charges information

4) Construction of hard commands for plotter

4.2.3 "FOGINT" (FOG Interphase)

"FOGINT" is a program to make a file conversion of the command file of "GPSL" so that it can be used as input to text type overlay generator FOG. The converted command file is converted to dot data by FOG and then drawn out by a Kanji printer. The output from this Kanji printer is realized at much greater speed than through a plotter, and figure display can be made with about the same level of accuracy as a plotter as long as the figure is not extremely complex.

4.2.4 "PLTWTR" (Output Writer for Plotter)

"PLTWTR" is an output writer which places the "GPSL" command file on the SYSOUT file by designation of the job control text and then outputs in one step with another job.

4.3 "VECTOR-FONT" (Vector Character Font Making Program)

The various characters of "GPSL" have vector properties, and there is need to automatically synthesize, correct, register, and remove these character fonts. "VECTOR-FONT" is a program to use the tablet connected to H-8844 to design a vector character font in conversational form and renovate and follow the character font for "GPSL" use.

4.4 "DOT-FONT" (Dot Character Font Synthesizing Program)

The various characters in "DEPP" are formed from dots, and there is need for a program which can automatically synthesize and correct these character fonts. "DOT-FONT" is a program which designs a dot character font in conversational manner in line with the desired character by entry with a stylus pen on the tablet connected to H-8844 and make corrections and follow the "DEPP" character font file (Kanji glossary). At this time it is also possible to alter the size of the characters being formed. An example of characters designed by "DOT-FONT" is shown in Fig 5.

4.5 "LINEPLOT" (Line Image Drawing Routine Assembly)

The plotting of prediction calculation data and experimental data in the design area can be conducted with the business routine of "GPSL," but it is often desirable to display part of this business graph through a line printer or a character display facility. "LINEPLOT" is a routine which can be used to display 16 types of graphs including bar graphs, circular graphs, and spiderweb graphs, and it has the same type interphase with "GPSL."

4.6 "APL/PLOT" (Graph Drawing Program for APL Use)

"APL/PLOT" is a program for drawing graphs for APL use and it is used not only for APL functions but can be used as is for command use. The principal capabilities of "APL/PLOT" are listed below.

1) It has a file for figure drawing data

2) It can display axial equations, upper and lower axial limits, tick marks, logarithmic scale, axial exchange, both terminal axes [literal], and axes labels type axial properties.

3) A number of figures can be placed on the same page

4.7 "TONE" (Dark and Light Output Routine Group)

The Kanji printer prints characters with a dot pattern. This is why it is possible to distinguish between dark and light by the density of the dot pattern. "TONE" is equipped with a routine which can call out 35 different types of dot patterns, and the user can take this routine to selectively finish the dot pattern and print dark and light figures with the printer line by line.

An example in which a FORTRAN program was outputted using "TONE" is illustrated in Fig 6.

5. Concluding Statements

The developmental situation of the various programs incorporated in basic software for CAD use was introduced along with the general outline. These programs include some which are software oriented and of a type which do not appear to be CAD related. There is great promise of spectacular future developments in the areas of data base systems for engineering use, structural analysis, figure processing, and software engineering, and the various programs which were discussed in this text are thought to serve as important foundations for such developments. A large number of application programs have been developed and put into actual use with the Hitachi Hitac M series general use computer. Future developmental subjects are the organic union of the various programs which have already been placed on the market with the design business and reprogramming a comprehensive system.

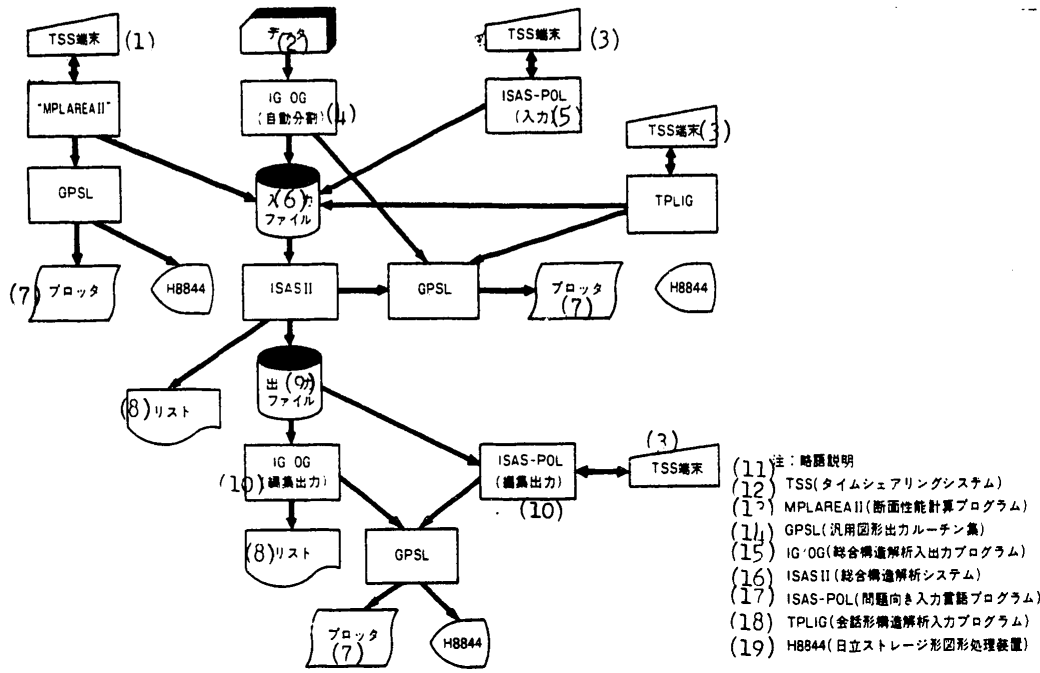

Figure 1. Complete Structural Analysis System

Indicating relationships between preprocessing programs, post processing programs, and figure output centered on structural analysis.

Key:

1. TSS terminal
2. Data
3. TSS terminal
4. (automatic division)
5. (input)
6. Input file
7. Plotter
8. List
9. Output file
10. (compiled output)
11. Note: explanation of abbreviations
12. TSS (time sharing system)
13. MPLAREA II (cross-sectional capability calculation program)
14. GPSL (general figure output routine group)
15. IB/OG (comprehensive structural analysis input-output program)
16. ISAS II (comprehensive structural analysis system)
17. ISAS-POL (program oriented input language program)
18. TPLIG (conversational type structural analysis input program)
19. H 8844 (Hitachi storage type figure processing facility)

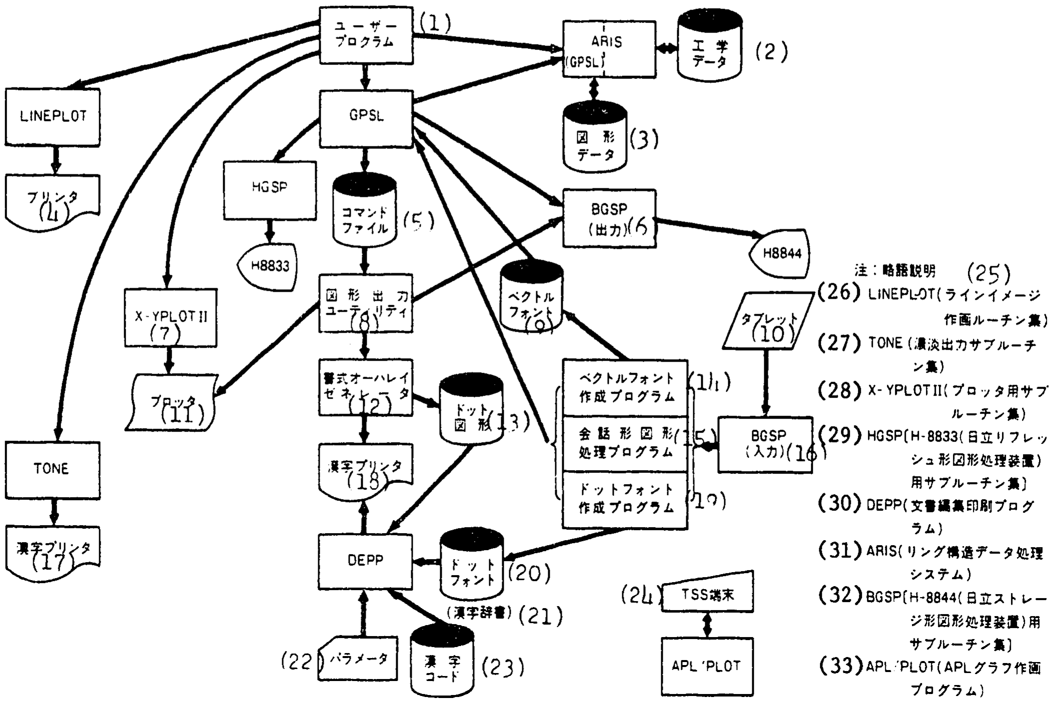

Figure 2. Complete Figure Processing System

Showing relationships between various output devices and figure processing program groups.

Key:

1. User's program
2. Engineering data
3. Figure data
4. Printer
5. Command file
6. (output)
7. X-Y PLOT II
8. Figure output utility
9. Vector font
10. Tablet
11. Plotter
12. Written overlay generator
13. Dot figure
14. Vector font composing program
15. Conversational type figure processing program
16. (input)
17. Kanji printer
18. Kanji printer
19. Dot font composing program
20. Dot font
21. Kanji dictionary
22. Parameter
23. Kanji code
24. TSS terminal
25. Note: explanation of abbreviations
26. LINEPLOT (line image figure drawing routine group)
27. TONE (dark and light output subroutine group)
28. X-Y PLOT II (subroutine group for plotter use)
29. HGSP [H-8833 (subroutine group for Hitachi refresh type figure processing device)]
30. DEPP (text compilation and printing program)
31. ARIS (ring structure data processing system)
32. BGSP [H-8844 subroutine group (for Hitachi storage type figure processing system) use]
33. APL/PLOT (APL graph construction program)

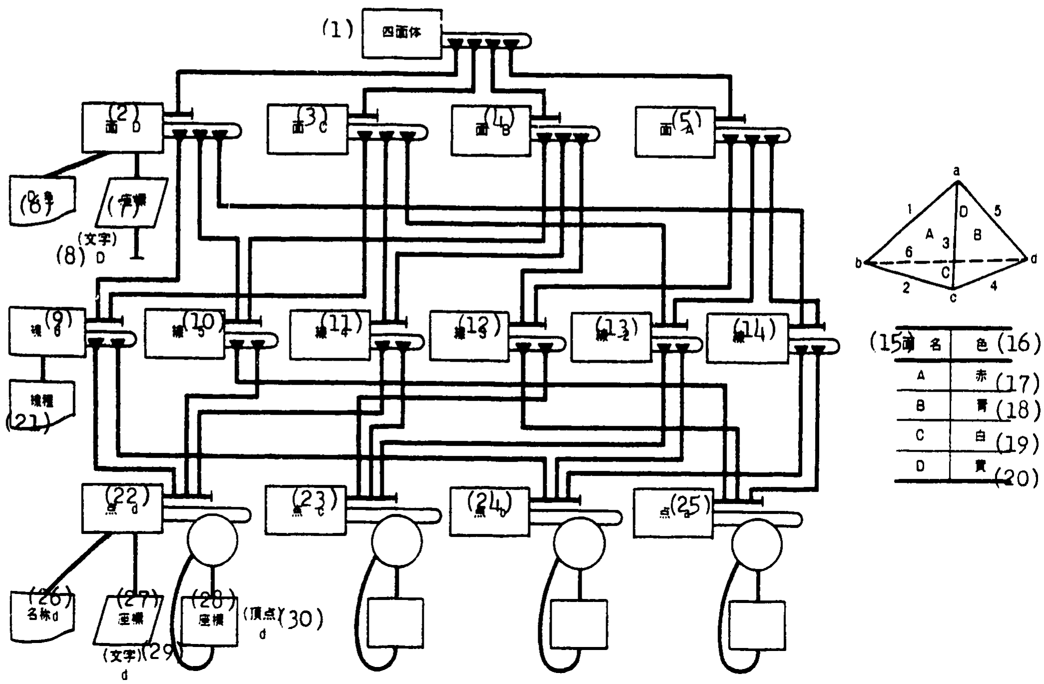

Figure 3. Tetrahedral Data Structure

Names formed with large Kanji characters on the faces of the tetrahedron, names formed with lower case Roman alphabet at the apices, and names formed from numbers on ridge lines.

Key:

1. Tetrahedron
2. Face D
3. Face C
4. Face B
5. Face A
6. Color D
7. Coordinate
8. (character) D
9. Line 6
10. Line 5
11. Line 4
12. Line 3
13. Line 2
14. Line 1
15. Face number
16. Color
17. Red
18. Blue
19. White
20. Yellow
21. Line type
22. Point d
23. Point c
24. Point b
25. Point a
26. Name d
27. Coordinate
28. Coordinate
29. (character)
30. (apex) d

Table 1. Types of Figure Data

This is a display of parent-child relationships of various components which make up figure data.

種類 (1)	(2) 意味
(3) 要素	線分，折線，円，円弧，文字列など操作可能な最小単位 (4)
(5) 部品	要素を複数個集めて，１個の図形データとして扱う。部品と要素を複数個集めて親部品としてもよい。部品は全ユーザーが処理可能な共通部品と，一ユーザーだけが処理可能な個別部品とに分かれる。(6)
(7) 層	要素や部品を複数個集めて，１個の図形データとして扱う。(8)
(9) 図面	任意の層を重ねて見ることによって図形を表現できる。(10)

Key:

1. Type
2. Definition
3. Element
4. Line segment, bent line, circle, arc, or row of characters type operable minimum unit
5. Part
6. A number of elements are put together and handled as a single figure datum. It is possible to put together a number of elements and parts to be used as a parent item. Parts are classified into those which all users can process and those which only a single user can process
7. Layer
8. A number of elements and parts are put together and handled as a single figure datum
9. Diagram
10. Any number of layers are stacked to display a figure

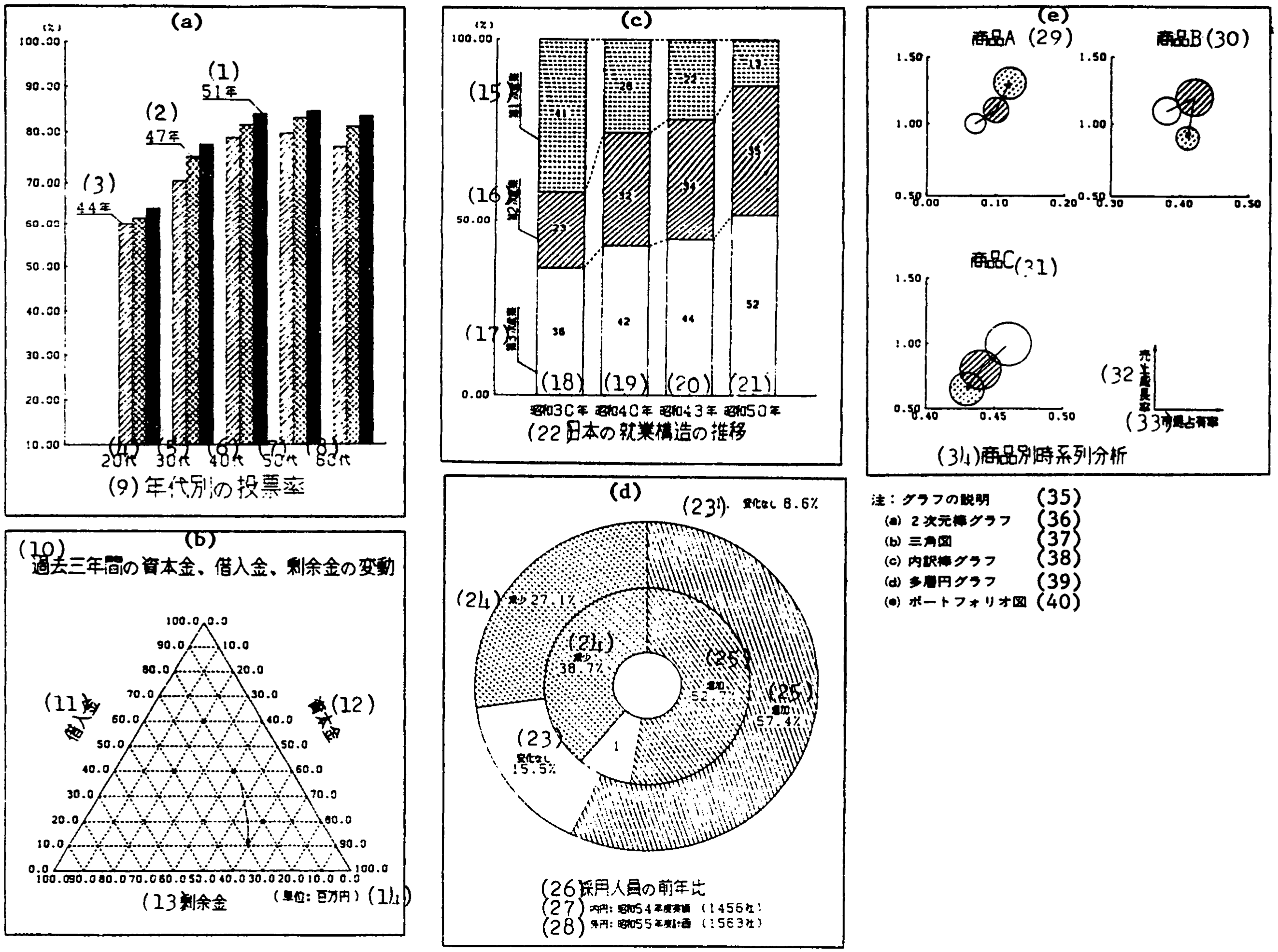

Figure 4. GPSL Business Graph
A representative graph was selected from 22 types of business graphs.

[Key on following page]

Key:

1. 1976
2. 1972
3. 1969
4. 20-year generation
5. 30-year generation
6. 40-year generation
7. 50-year generation
8. 60-year generation
9. Voting rate by age classes
10. Trends in capital, loans, and surplus funds over the past 3 years
11. Loans
12. Capital fund
13. Surplus funds
14. (unit: million yen)
15. Primary industry
16. Secondary industry
17. Tertiary industry
18. 1955
19. 1965
20. 1968
21. 1975
22. Trends in Japan's employment structure
23. No change--%
24. Decrease--%
25. Increase--%
26. Ratio of people employed compared to preceding year
27. Inner circle: record for JFY 1979 (1456 companies)
28. Outer circle: projected for JFY 1980 (1583 companies)
29. Product A
30. Product B
31. Product C
32. Growth rate in sales
33. Fraction of market
34. Time sequence analysis by products
35. Note: explanation of graphs
36. (a) 2-dimensional bar graph
37. Triangular graph
38. Internal breakdown bar graph
39. Multiple layer circular graph
40. Portfolio graph

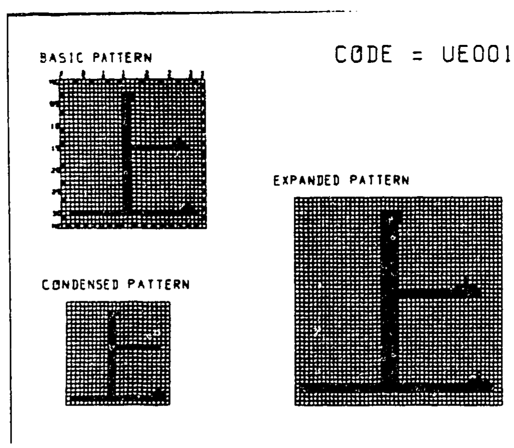

Figure 5. Dot Pattern Figure

The character "上" was inputted on the tablet in standard size design after which reducing and expanding size patterns were created and displayed simultaneously on H-8844 as hard copy.

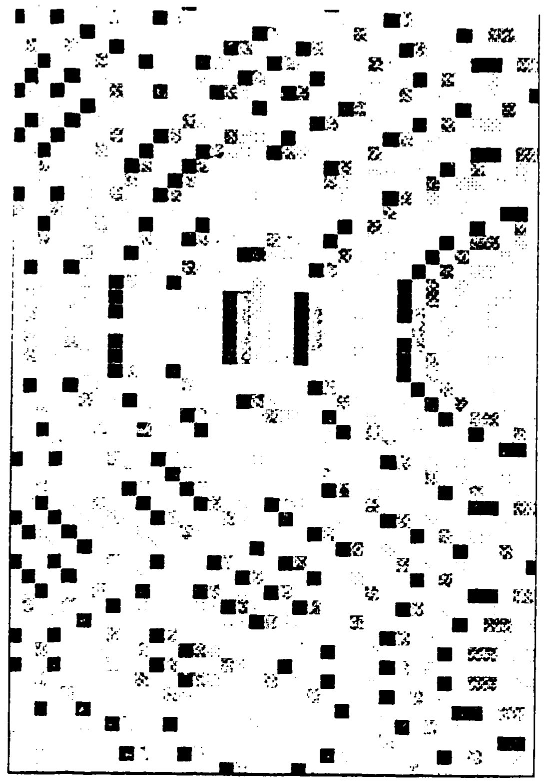

Figure 6. Example of Light and Dark Output

Six types of dark and light patterns were processed with Fortran program and then outputted on a Model H-8195 Kanji printer.

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END